ME-1904 C.1

REFERENCE

RUCTION

MANUAL

ME 1904
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ME-1904

TYPE RM561A OSCILLOSCOPE

MANUFACTURERS OF CATHODE-RAY OSCILLOSCOPES

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c.1

INSTRUCTION MANUAL

Serial Number _____

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TYPE RM561A OSCILLOSCOPE

Tektronix, Inc.
S.W. Millikan Way ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-0352-01

WARRANTY

All Tektronix instruments are warranted against defective materials and workmanship for one year. Tektronix transformers, manufactured in our own plant, are warranted for the life of the instrument.

Any questions with respect to the warranty mentioned above should be taken up with your Tektronix Field Engineer.

Tektronix repair and replacement-part service is geared directly to the field, therefore all requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type and Serial number with all requests for parts or service.

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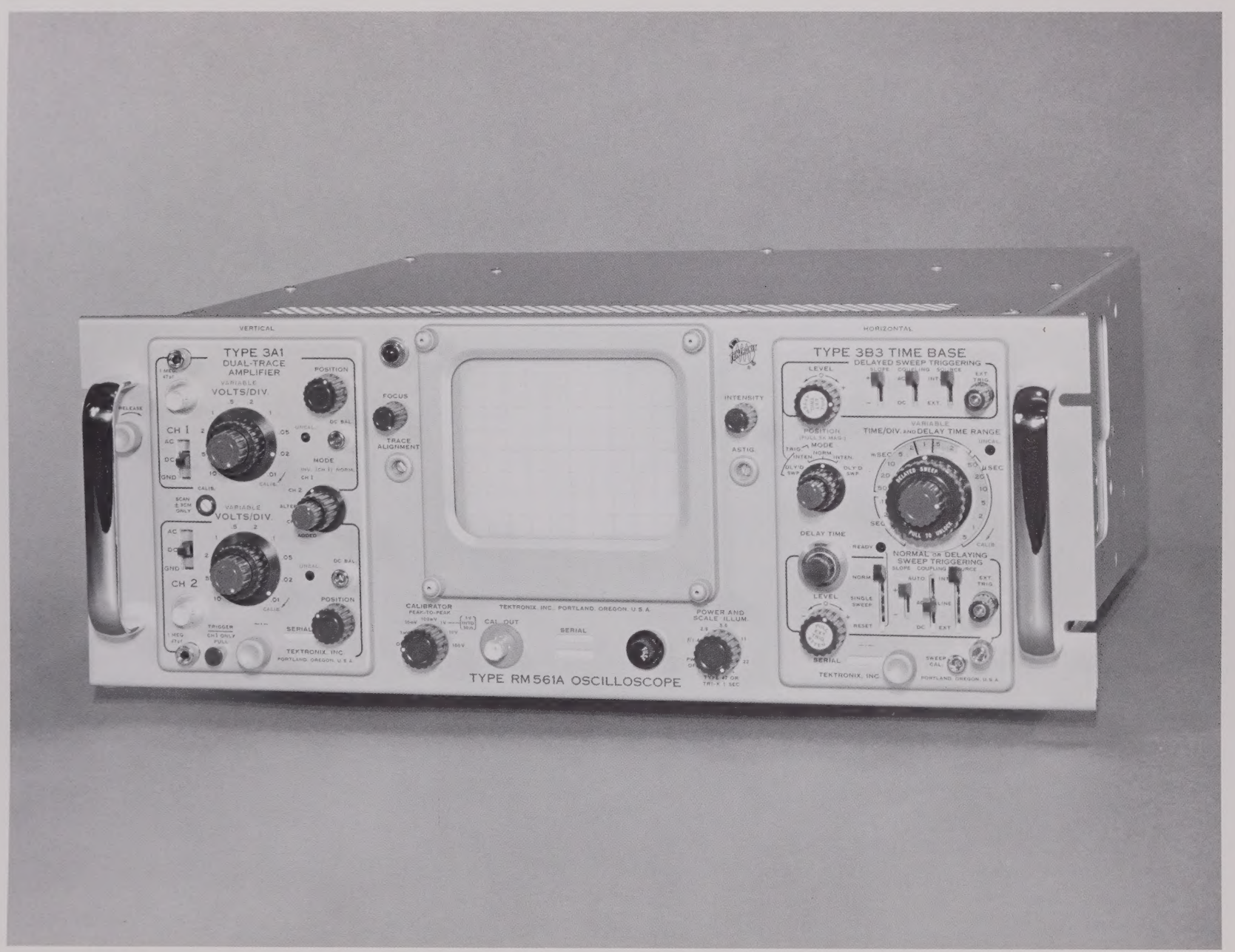
Abbreviations and symbols used in this manual are based on, or taken directly from, IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.


VERTICAL
TYPE 3A1
DUAL-TRACE
AMPLIFIER
VARIABLE
VOLTS/DIV.
POSITION
CH 1
CH 2
MODE
DC BAL
CALIB.
SERIAL
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.
FOCUS
TRACE ALIGNMENT
INTENSITY
ASTIG.
TEKTRONIX, INC. PORTLAND, OREGON, U.S.A.
CALIBRATOR
PEAK-TO-PEAK
CAL. OUT
SERIAL
POWER AND
SCALE ILLUM.
HORIZONTAL
TYPE 3B3 TIME BASE
DELAYED SWEEP TRIGGERING
LEVEL
SLOPE
COUPLING
SOURCE
EXT. TRIG.
POSITION
TIME/DIV. AND DELAY TIME RANGE
DELAY TIME
NORMAL OR DELAYING
SWEEP TRIGGERING
SINGLE SWEEP
RESET
SWEEP CAL.
TEKTRONIX, INC.
PORTLAND, OREGON, U.S.A.
TYPE RM561A OSCILLOSCOPE

SECTION 1

CHARACTERISTICS

General Information

The Tektronix Type RM561A Oscilloscope is essentially an indicator unit with provision for two plug-in units. The plug-in unit in the right-hand opening controls the horizontal (X-axis) deflection, and the plug-in unit in the left-hand opening controls the vertical (Y-axis) deflection. The plug-in units can be selected from any of the Tektronix '2' Series or '3' Series groups to provide the desired oscilloscope performance.

Cathode-Ray Tube

Type—T5032-31-1 (rectangular ceramic-envelope).

Phosphor—P31.

Unblanking—Deflection type, dc-coupled, with grid intensification.

Graticule—Variable edge lighted "no parallax" internal graticule. Marked in 8 vertical and 10 horizontal divisions with each major division divided into 5 minor divisions on centerlines.

Accelerating voltage—3.5 kv.

Useable viewing area—8 divisions vertical by 10 divisions horizontal.

Deflection factors—18.5 to 20.5 volts per centimeter vertical, and 17.5 to 19.3 volts per centimeter horizontal.

Calibrator

Waveform—Square waves at line frequency.

Output voltage—1 millivolt to 100 volts, peak-to-peak, in 6 steps. The 1 v position provides an output of 0.1 volt into 50 ohms.

Accuracy—Peak-to-peak amplitude within 3% of indicated voltage.

Risetime—Typically 5 microseconds.

Power Supplies

Electronically regulated for stable operation with normal line voltage variations and widely varying loads. The low voltage supplies hold regulation within ±1% of value.

Line voltage requirements—105 to 125 volts, or 210 to 250 volts, rms, 50 to 60 cps, single-phase ac.

Fuse requirements—3-amp slow-blowing type for 117 volts, 1.25-amp slow-blowing type for 234 volts.

Ventilation

Forced air cooled. Automatic-resetting thermal cutout interrupts instrument power if internal temperature exceeds about 123° F.

Construction

Aluminum-alloy chassis.

Photo-etched anodized front panel.

Weight—30½ pounds, indicator unit only.

Dimensions—see Dimension Drawing at rear of manual.

NOTES

SECTION 2

OPERATING INSTRUCTIONS

Introduction

Before operating the Type RM561A Oscilloscope, be sure that the instrument will cool properly, the proper line voltage is used and the crt deflection potentials are correct. Function of front-panel controls and operating considerations are given in this section.

Cooling

A fan at the rear of the Type RM561A provides cooling. The entire fan assembly is in a snap-in mounting that can be mounted to exhaust air at the rear of the instrument or draw air in at the rear and blow it throughout the instrument. Direction of air flow can be changed to meet the operating conditions.

The Type RM561A can operate in ambient temperatures up to 50° C. If the instrument overheats, the thermal cutout turns off the power. When the internal temperature drops to a safe operating level, power is automatically restored. If wired for 117-volt operation, the fan will continue to operate when the thermal cutout opens. On 234-volt operation, power for the fan is turned off when the thermal cutout opens.

Line Voltage

The Type RM561A can be wired for either 117-volt or 234-volt operation. It will operate properly between 105 and 125 volts when wired for 117-volt operation and between 210 and 250 volts when wired for 234-volt operation.

Converting from one operating voltage to the other requires a change in the power transformer primary connections, fan connections, fuse and line cord plug. Figs. 2-1 and 2-2 indicate the transformer primary and fan connections for 117-volt and 234-volt operation. A 3-amp slow-blow type fuse is required for 117-volt operation and a 1.25-amp slow-blow type fuse is required for 234-volt operation.

Front Panel Controls

The POWER ON switch and SCALE ILLUM. control permit turning the instrument power on or off and provide adjustment of the brightness of the graticule markings.

The FOCUS control adjusts the trace or spot focus.

The ASTIG. control is used in conjunction with the FOCUS control, to assure proper focus over the entire crt display.

The INTENSITY control adjusts the crt display brightness.

The ALIGNMENT control permits electronic alignment of the crt trace to match the horizontal graticule markings.

The 7-position CALIBRATOR switch determines the peak-to-peak amplitude of the signal at the CAL. OUT connector. It also turns the Calibrator on or off.

Rear Panel Controls

The CRT CATHODE SELECTOR switch permits the operator to select either (1) internal DUAL-TRACE CHOPPED BLANKING to remove dual-trace chopped mode switching transients from the crt display, or (2) Z-axis intensity modulation by external signals.

Operation

Operation of the Type RM561A Oscilloscope with two plug-in units in place is much the same as that of a Tektronix oscilloscope with corresponding vertical and horizontal deflection systems built into the main frame. The plug-in

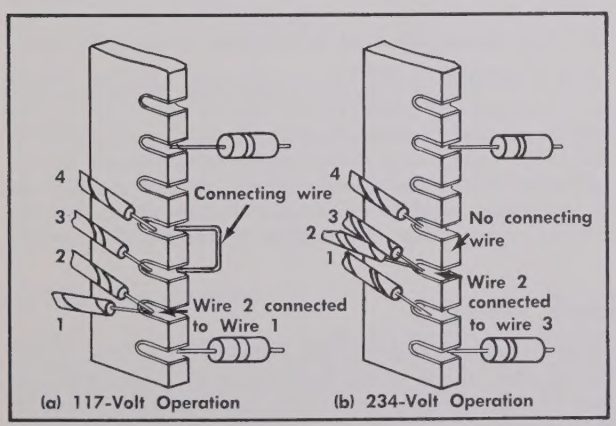


Fig. 2-1. Power transformer primary connections for operation at (a) 117 volts or (b) 234 volts.

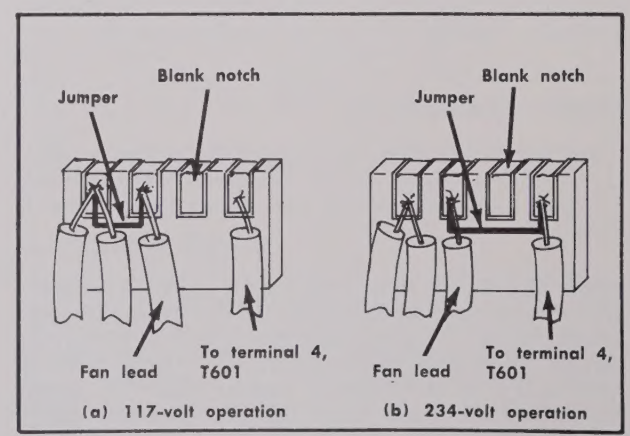


Fig. 2-2. Fan terminal strip located near thermal cutout. (a) 117 volts, (b) 234 volts.

units are the vertical and horizontal deflection systems; their outputs connect directly to the deflection plates of the cathode-ray tube. The plug-in units can be selected to give the Type RM561A Oscilloscope the degree and type of performance required for a particular application.

The controls and switches on the Type RM561A affect the display; however, the plug-in units determine the major characteristics of the system.

Calibrator Output

The Calibrator output signal of the Type RM561A provides a convenient signal source for setting the gain of an amplifier plug-in unit or the basic timing of a time-base plug-in unit. The 1 V position also provides a 0.1 volt amplitude signal when connected to a 50-ohm system. This is very useful for calibrating sampling plug-in units. See the plug-in unit Instruction Manual for complete adjustment procedure.

In addition to these applications, the Calibrator output signal can be used as a convenient square-wave signal source for other applications.

NOTE

When using the Calibrator output signal as a signal source for a system sharing a common ground with the Type RM561A (including plug-ins used in the instrument) be sure that the outer conductor of the CAL. OUT connector is connected to the chassis (or ground). Otherwise, the current through the Calibrator ground resistor, R899, may cause an incorrect Calibrator output signal.

CRT CATHODE SELECTOR Switch

The CRT CATHODE SELECTOR switch provides two modes of operation; CHOPPED BLANKING for dual-trace amplifier plug-ins and EXT CRT CATHODE for intensity modulation of the display.

The CRT CATHODE SELECTOR switch should be left in the CHOPPED BLANKING position except when external intensity modulation is used. For normal operation the shorting plug should connect the EXT CRT CATHODE jack to ground. Remove the plug for Z-axis modulation.

Display Combinations

The plug-in unit in the right opening of the Type RM561A controls the horizontal (X-axis) deflection of the crt beam. The unit in the left opening controls the vertical (Y-axis) deflection.

Conventional Display. To obtain the conventional display of a horizontal sweep with vertical deflection by the input signal, insert a time-base plug-in unit in the right-hand opening and an amplifier unit in the left. If a vertical sweep is desired with the input signal displayed horizontally, reverse the plug-ins. However, in this manner, the sweep retrace will not be blanked. Retrace blanking is provided only when a time-base unit is inserted in the right side of the Type RM561A.

X-Y Display. To obtain an X-Y display, insert amplifier plug-in units in both plug-in openings. Plug-in units with equal characteristics should be used.

Intensity Modulated Display. The crt beam can be intensity modulated (Z-axis modulated) by applying a signal to the EXT CRT CATHODE jack on the rear panel. Depending on the setting of the INTENSITY control, the crt beam can be turned on with a negative pulse, or off with a positive pulse.

To intensity modulate the display remove the shorting strap from between the EXT CRT CATHODE and GND jacks. Set the CRT CATHODE SELECTOR switch to the EXT CRT CATHODE position and apply the modulating signal to the EXT CRT CATHODE jack.

Changing Plug-in Units

Before inserting a plug-in unit into the Type RM561A Oscilloscope, make sure the latching bar (bottom front) is not pointing down. Then, push the plug-in unit all the way into the opening. Turn the aluminum knob at the bottom center of the unit clockwise until it is tight. To remove the unit, turn the knob counterclockwise several turns and pull the unit out of the plug-in compartment.

CAUTION

Although most plug-in units can be inserted or removed without damage when the power is on, best protection is provided for all units by turning the power off before changing units.

Different plug-in units apply slightly different dc voltages to the crt deflection plates. The Type RM561A crt has higher horizontal deflection sensitivity than vertical deflection sensitivity. Also, changing one plug-in unit can affect the accuracy of the other unit installed. Therefore, if one or both of the units are replaced, check the gain of both units. If a plug-in needs adjustment, follow the directions in the applicable Instruction Manual to adjust gain or sweep timing.

When the plug-in units are changed, the FOCUS and ASTIG. controls on the Type RM561A may need readjustment.

The Type RM561A can be operated with only one plug-in unit if desired. For example, moving film recording may be used in place of a sweep plug-in unit. To operate with only one plug-in unit, it will be necessary to elevate the unconnected crt deflection plates to about +170 to +210 volts dc vertical or +150 to +180 volts dc horizontal. This will provide proper action of the FOCUS and ASTIG. controls.

Blank Chassis

Blank plug-in unit chassis are available to build your own plug-in unit for use in the Type RM561A. Order Modification Kit 040-245 from your local Tektronix Field Office or representative.

SECTION 3

CIRCUIT DESCRIPTION

Introduction

The Tektronix Type RM561A Oscilloscope has a low-voltage power supply circuit, a cathode-ray tube circuit, and a calibrator.

The low-voltage power supply circuit provides the regulated and unregulated power used by the instrument and the plug-in units.

The crt circuit has the necessary controls and input facilities needed to give a sharp trace of useable intensity. Two negative high-voltage power supply outputs are used for the cathode, focus element, and control grid of the crt.

The calibrator produces amplitude-calibrated square waves.

LOW-VOLTAGE POWER SUPPLY

The low-voltage power supply circuits have regulated outputs of —100, —12.2, +125, and —300 volts, and unregulated output of +420 volts. These circuits use silicon diode rectifiers and series-regulators. Each regulator circuit has a vacuum tube (or transistor, in the case of the —12.2-volt supply) in series with the load. This tube's series plate resistance (and current) is controlled to maintain a constant voltage drop across the load. For example, if the load increases the series tube plate resistance decreases to pass more current to the load. If the load decreases it passes less current. In both cases, the voltage across the load remains the same.

The —100-, +125-, and +300-volt regulated supplies require shunt resistors when supplying more current than can be handled by the series tube. A shunt allows some of the load current to bypass the supply-series-regulator tube. The size of the shunt is very important. If the shunt resistance is too high, the series tube can overheat; if the resistance is too low, the supply can fail to regulate. If a plug-in draws an amount of current that calls for a supply shunt, the correct shunt resistance is located in that plug-in unit. When the unit is plugged into the Type RM561A, the shunt is connected around the series regulator tube. The plug-in portion of the shunt is always in series with a resistor located in each power supply circuit.

Power for the Type RM561A Oscilloscope and its plug-in units is supplied through the power transformer T601. The two primary windings of T601 are connected in parallel for 117-volt operation, or in series for 234-volt operation, as shown on the schematic diagram.

—100-Volt Supply

Reference voltage for the —100-volt supply is established by the gas diode, V609. The constant voltage drop across V609 establishes a fixed potential of about —85 volts at the grid of V634B. Voltage at the grid of V634A is established by the divider R616, R617, and R618. The difference in voltage between the two grids of V634 determines the plate current of V634A. Plate current of V634A determines the base voltage of transistor Q624 which in turn determines the grid voltage of the series tube, V627. The series tube plate resistance changes to hold the load voltage constant. R616, —100 VOLTS adjustment, determines the percentage of the total divider voltage applied to the grid of V634A and thus controls the output voltage. When this control is properly adjusted, the output is exactly —100 volts.

Should the output voltage tend to change because of a change in input voltage or a change in load current, the potential at the grid of V634A will change a proportional amount. Any change at the grid of V634A is amplified by V634A and Q624 and applied to the grid of V627. The resulting grid change at V627 will cause its plate resistance to change in the direction needed to bring the output back to —100 volts. C616 improves the response of the regulator to sudden changes in output voltage. R628 is part of the series tube shunt, connected by some plug-in units.

+125-Volt Supply

The —100-volt supply serves as a reference for the +125-volt supply. With the R651 end of the divider R650-R651 fixed at —100 volts, any change in the +125-volt output produces a proportional change at the grid of V654. This change is amplified and supplied to the grid of the series regulator tube, V667A. The change at the grid of V667A changes its plate resistance to bring the output voltage back to +125 volts. R656, the +125 VOLTS control, determines the percentage of total divider voltage applied to the grid of V654 and permits adjustment of the output voltage. When this control is properly adjusted, the output is exactly +125 volts. C650 improves the response of the regulator to sudden changes in output voltage. R666 is part of the series tube shunt.

+300-Volt Supply

The +300-volt supply works the same as the +125-volt supply. To supply the voltage for the +300-volt regulator, rectified voltage from the transformer pins 21 and 22 is added to the voltage supplying the +125-volt regulator. R676, the +300 VOLTS control, adjusts the output voltage.

The +300-volt supply has an unregulated output of +420-volts for the crt circuit.

—12.2-Volt Supply

Operation of the —12.2-volt regulating circuit is essentially the same as that of the other regulating circuits, except that transistors are used instead of vacuum tubes. The base of Q734 is fixed near —12 volts by the voltage divider R731-R732 between —100 volts and ground. Any variation of the —12.2-volt output at the emitter of Q734 is amplified by Q734 and Q744 to change the collector resistance of Q757 which is in series with the load. R730, the —12.2 VOLTS control, allows adjustment of the voltage

applied to the base of Q734 and thus the output voltage. When this control is properly adjusted, the output is exactly —12.2 volts. F720 protects Q757 in case of an overload on the —12.2-volt supply.

CRT CIRCUIT

The crt circuit contains the cathode-ray tube and two high-voltage supplies (one for the crt and focus element, the other for the control grid). The circuit also contains the necessary controls and signal input facilities.

Cathode-Ray Tube

A Tektronix T5032-31-1 ceramic-envelope cathode-ray tube is used in the Type RM561A. The accelerating voltage is approximately 3500 volts, developed by about —3300 volts at the cathode and an average deflection plate voltage of about +200 volts. With this accelerating voltage, the nominal vertical and horizontal deflection factors are 19.5 and 18.4 volts per centimeter respectively.

Deflection blanking of the crt beam is used in the Type RM561A. The crt contains a special set of deflection plates, pins 6 and 7, for this purpose. Both plates are connected to +125 volts; however pin 6 is also driven by the horizontal plug-in unit.

During sweep time, or if no plug-in unit is installed, both plates rest at +125 volts and permit the electron beam to pass on to the crt phosphor. During sweep retrace, however, pin 6 is driven considerably away from +125 volts by the right-hand plug-in unit. This scatters the beam and prevents it from being displayed.

High-Voltage Supplies

Energy for both high-voltage supplies is furnished by T801. V800, the primary of T801, and the stray circuit capacitance form a Hartley oscillator which operates at about 45 kc.

The output of one secondary winding of T801, rectified by V822, provides voltage for the crt cathode and focus element. This voltage is about —3300 volts at the crt cathode, and between about —2200 and —3000 volts at the focusing element, depending on the setting of the FOCUS control. The 6.3-volt crt heater is elevated to the cathode potential by R851.

The output of the other secondary winding of T801 is rectified by V832 for the control grid. The grid voltage ranges from —3200 to —3450 volts, depending on the setting of the INTENSITY control. The reference to ground for this supply is determined by the voltage at the junction of diodes D838 and D839. The voltage at this junction, plus the setting of the INTENSITY control, determines the crt bias and therefore the intensity of the display.

Two neon bulbs, B856 and B857, keep the voltage between the grid and cathode of the crt within safe limits. If the voltage exceeds about 140 volts, the neons fire and the voltage reduces to about 120 volts.

Regulation of the —3300-volt supply is accomplished through feedback from the arm of R841. The —3450-volt supply is regulated indirectly by mutual coupling in T801. If, because of loading or a change in input voltage, the output of the —3300-volt supply changes, a proportionate change occurs at the arm of R841. This change is amplified by V814 and is coupled to the screen of V800. The resulting change in screen voltage of V800 will increase or decrease the amplitude of oscillations in V800, changing the output voltage of T801 in the direction needed to return the high voltage to the correct level. The HIGH VOLTAGE control, R841, permits adjustment of the output voltage by setting the bias on V814B.

Deflection Signals

Push-pull signals for the deflection plates appear at pins 17 and 21 of the plug-in connector. The effective deflection-circuit capacitance these signals see at the connector affects the bandpass and phase shift of each plug-in unit. C760 and C761 (Interconnecting Socket diagram) are set at the factory.

Intensifying Signals

Two signals may be used to modulate the intensity of the crt display. First, intensifying signals from a two-sweep (delaying-sweep) time-base plug-in unit are applied to the grid supply through pin 14 of the right-hand Interconnecting Socket. When the overall display intensity is reduced with the INTENSITY control, positive intensifying pulses from a two-sweep time-base plug-in unit will brighten any desired portion of the display.

The ground return for the crt grid supply can be either through D838 in the case where the plug-in unit does not supply intensifying signals or through D839 to a negative voltage in the intensifying circuit of the plug-in unit. In the second case D838 is back-biased and the junction of D838 and D839 is at a low negative voltage. With the same setting of the INTENSITY control, the first case will provide a brighter display. The second case provides a slightly dimmer display due to the plug-in unit negative voltage. Intensification results when the plug-in unit positive pulse turns D839 off and the crt grid supply return again becomes D838. R837 and C837 then couple the leading edge of the intensifying pulse directly to the crt grid.

Other external intensifying signals can be fed to the crt cathode through the EXT CRT CATHODE jack. Depending on the setting of the INTENSITY control, a negative pulse of 5 volts or more will turn the crt beam on.

Crt Controls

The INTENSITY control, R833, has a range of about 250 volts to control the crt bias and permit changing the intensity of the display.

The FOCUS control, R844, adjusts the focus of the crt by varying the voltage at the focusing anode through a range from about —2200 to —3000 volts.

The ASTIG. control, R864, has a 300-volt adjustment range.

The GEOMETRY control, R865, adjusts the geometry by varying the voltage of the crt isolation shield through a range from +180 to +246 volts.

The TRACE ALIGNMENT control, R860, rotates the display so it can be aligned with the graticule.

CALIBRATOR

The calibrator for the Type RM561A Oscilloscope produces line-frequency amplitude-calibrated square waves. The 6.3-volt (approximately 18 volts peak-to-peak) ac heater voltage for V884 is applied through C876 to the cathode of V884A. The signal at the plate of V884A is coupled to the grid of V884B to turn that tube on and off. Regenerative feedback from the plate of V884B to the grid of V884A speeds up the switching action, and drives V884A into and out of cutoff.

The voltage present at the cathode of V884B during the time that V884B is conducting is adjusted to exactly 100 volts with the CAL. AMPL. adjustment, R871. The voltage divider in the cathode circuit of V884B contains precision resistors to provide an output accuracy of 3% or better at the various settings of the CALIBRATOR control.

When the CALIBRATOR control is set to the 1V position, there will be a 0.1-volt output when the CAL. OUT connector is terminated in 50 ohms.

NOTES

SECTION 4

MAINTENANCE

PREVENTIVE MAINTENANCE

Cleaning

Occasionally blow the dust out of the instrument with a low-velocity dry air stream. Remove persistent dirt with a small paint brush or damp cloth. The screen on the fan can be snapped out and should be cleaned as needed. Check it frequently.

Fan Oiling

The fan should be oiled with a few drops of oil about every six months. An industrial hypodermic syringe and needle is used to insert oil through a protective rubber cap located under the fan label. The oil recommended is Anderol L826 from the Lehigh Company or Rotron distributors, but if not available, a good light machine oil may be used. If a syringe and needle cannot be obtained locally, you can order them through your local Tektronix Field Office by specifying Hypodermic Syringe, Tektronix Part No. 003-282 and Hypodermic Needle, Tektronix Part No. 003-285.

Fig. 4-1 shows how to oil the fan. Place the needle at the point on the label shown in Fig. 4-1. With the needle at about 45°, pierce the label and rubber cap (located under the label); insert the needle about ¼" and depress the syringe-plunger to inject a few drops of oil.

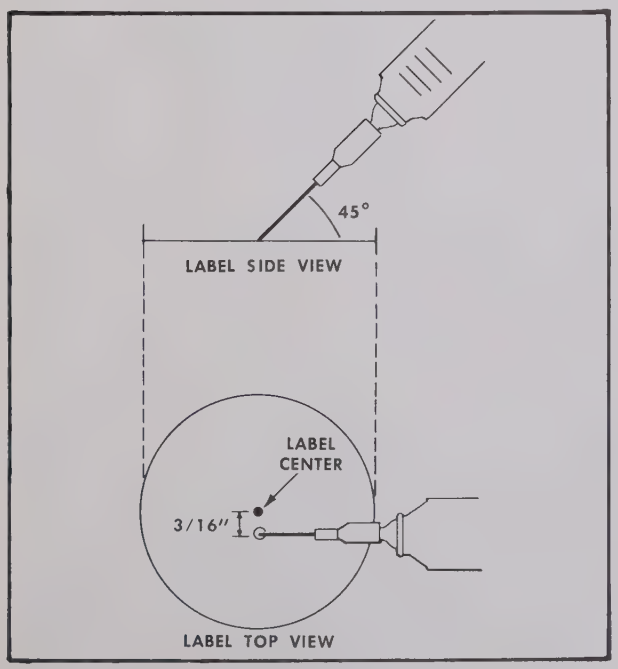


Fig. 4-1. Fan motor oiling with hypodermic.

CORRECTIVE MAINTENANCE

Replacing Parts

Most parts in the Type RM561A Oscilloscope can be replaced without detailed instructions. Some parts, however, should be replaced by using definite procedures. These procedures are described in the following paragraphs.

A replaced part may affect instrument calibration. Check and adjust where needed.

Soldering Precautions and Procedure

In Tektronix instruments, parts are connected to ceramic terminal strip notches with solder containing about 3% silver. The bond between the notch and ceramic strip may be broken by repeated use of ordinary 60-40 tin-lead solder or by excessive heat. Therefore, when resoldering parts to a ceramic strip use solder containing 3% silver and do not overheat the work. Occasional use of ordinary solder, however, will not break the bond.

Usually 3% silver solder is available locally; or one-pound rolls may be purchased through your Tektronix Field Office by ordering Tektronix Part Number 251-514.

The following soldering procedure may be used to remove and replace parts on a ceramic terminal strip.

1. Use 50- to 70-watt soldering iron with a wedge shaped tip. (With this type tip you can heat the solder slot without overheating the strip.)

2. Tin the soldering iron tip with silver-bearing solder.

3. Heat the parts soldered to the ceramic strip only enough to make the solder flow freely. Do this by touching one corner of the soldering iron tip to the notch. (Be careful: excessive pressure will break the ceramic strip.)

4. When you remove a part, pull its lead out of the notch while the solder is hot.

5. When you replace a part use only enough solder to cover the wires and form a small fillet in the notch.

6. Clip excess leads of parts replaced and be sure to remove all clippings from the instrument.

Replacing Ceramic Terminal Strips

Damaged ceramic terminal strips can be replaced by the following procedure. Fig. 4-2 shows how ceramic strip parts are assembled.

1. Unsolder all connections to damaged ceramic strip.

2. Cut off one side of each plastic yoke holding the old ceramic strip.

3. Remove old ceramic strip.

4. Remove remainder of old yokes from spacers.

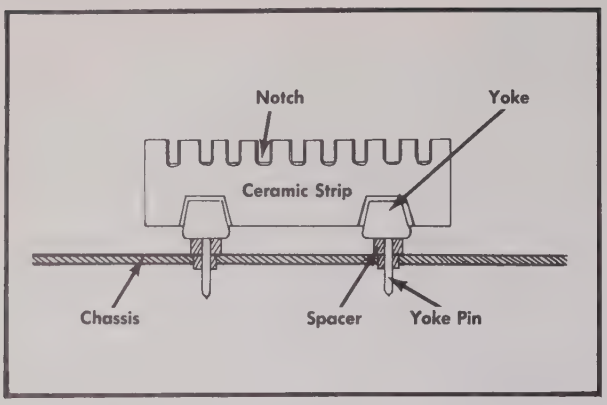


Fig. 4-2. Ceramic terminal strip assembly.

5. Replace old spacers with new ones. (If not damaged, spacers can be reused.)

6. Set new ceramic strip yoke pins into spacers.

7. Drive new yoke pins completely into spacers by pressing or lightly tapping the ceramic strip directly above the yokes. Be careful, don't break strips.

8. Cut off portion of new yoke pins protruding through spacers on side of chassis opposite the ceramic strip.

9. Resolder connections to new ceramic strip using the information headed Soldering Precautions and Procedure.

Replacing Calibrator Switch

The entire switch should be replaced and can be ordered either wired or unwired.

Cathode-Ray Tube

WARNING

When replacing crt, wear a plastic face mask and protective gloves for protection in case tube implodes.

To remove the cathode-ray tube, disconnect the four leads connected to the neck of the tube, the tube socket, and loosen the tube clamp on tube base. Remove the crt bezel, light reflector and light shield. Pull the crt straight out through the front panel, being careful not to bend or break the crt neck pins. The rubber gasket and implosion shield can be removed from the crt face after it is out of the instrument.

Install the new crt by the reverse of the preceding procedure. When replacing the implosion shield be sure that the notched side is down. Follow the color-code information on the tube shield when the crt neck pin leads are replaced. When the crt is properly installed, the back of its faceplate is flush with the instrument front panel.

After the crt is replaced, it may be necessary to adjust the TRACE ALIGNMENT and HIGH VOLTAGE controls and the deflection-circuit capacitance (C760 and C761) according to the calibration procedure. Also check the calibration of time-base and amplifier plug-in units.

TROUBLESHOOTING

If trouble occurs in the Type RM561A Oscilloscope, a five-step procedure may be used for repair. First confirm the trouble. Next, isolate trouble to a plug-in unit or to the Type RM561A. Localize a trouble in the Type RM561A to the Power Supply, Crt Circuit, or Calibrator. Troubleshoot the correct circuit to find defective parts. Replace the defective parts.

Confirmation of Trouble

Improper control settings may, at times, give indications of trouble. Therefore, you should be sure that the apparent trouble is not caused by improper front-panel control settings. For example, an improper setting of the SOURCE or COUPLING switch on a time-base unit can cause apparent triggering troubles; an improper setting of the VARIABLE control on an amplifier unit can cause an apparent decrease in sensitivity.

When a trouble exists, it must be isolated to one of the plug-in units or to the Type RM561A indicator.

Isolating Trouble

Isolating trouble to a plug-in unit or to the indicator can be done in one of two ways, depending on whether or not there are spare plug-in units available.

If trouble is found to be in the plug-in unit, refer to the instruction manual for that unit. A plug-in extension (Part Number 013-034, available through your local Tektronix Field Office) allows the units to be operated while extended out through the front of the plug-in opening.

Spare Plug-In Units Available

If more than two plug-in units are available, the easiest way to isolate trouble is to replace the plug-in units one at a time. The faulty unit can then be isolated by noting when proper operation is restored. If plug-in replacement does not correct the trouble, the Type RM561A is probably faulty.

NOTE

A non-sampling plug-in unit cannot be operated with a sampling plug-in unit.

Spare Plug-In Units Not Available

When spare plug-in units are not available, the crt display will be of great help. Trouble will normally show up as an erroneous display, or as no display at all. Since the crt display will help isolate the trouble, the following procedure is divided according to the type of display.

No Trace Or Spot. If no trace can be obtained on the crt, remove both plug-in units and vary the INTENSITY control. A spot should appear. If no spot appears, the trouble is in the Type RM561A. If a spot does appear when both plug-in units are removed reinsert each unit separately. After warm up, vary its POSITION control. If the spot or

trace cannot be returned to the approximate center of the crt when a single plug-in unit is in the indicator, the trouble is probably in that unit. (If a time-base unit is installed, be sure it is set for free-running operation to unblank the crt.)

Insufficient Vertical Deflection or Improper Sweep Timing. If the plug-in unit front-panel gain controls do not permit adequate vertical deflection or proper sweep timing, check the low-voltage and high-voltage power supply voltages (see schematics).

If the power-supply voltages are not correct, remove both plug-in units and check the voltages again. If they still are not correct, the trouble is in the Type RM561A indicator. If the power-supply voltages are correct with both plug-in units removed, but incorrect with only one of the two inserted, the trouble is in that unit. If the power-supply voltages are correct with both plug-in units removed, but incorrect when either is inserted, the trouble is probably in the power supply of the Type RM561A.

Improper Triggering. If external triggering and line triggering are satisfactory, but internal triggering is not, the trouble is probably in the Trigger Pickoff Circuit of the amplifier plug-in units. If satisfactory triggering cannot be obtained from any of the three sources (external, internal or line) the trouble is probably in the time-base plug-in unit.

Waveform Distortion. If there is any waveform distortion, but no other indications of malfunction (such as improper sweep timing) the trouble is probably in the vertical plug-in unit.

Localizing Trouble In Type RM561A Indicator

If it has been determined that trouble exists in the Type RM561A, the location of the trouble can be further localized to the Power Supply, the Crt Circuit, or the Calibrator.

To localize the trouble to either the Power Supply or the Crt Circuit, measure the output of each of the regulated power supplies. If incorrect supplies are measured, the trouble is in the Power Supply or the power source. If all of the measured voltages are proper, the trouble is in the Crt Circuit.

Trouble in the Calibrator is indicated by an erroneous output at the CAL. OUT connector.

When it is known which circuit contains the trouble, that circuit can be checked to locate the defective component.

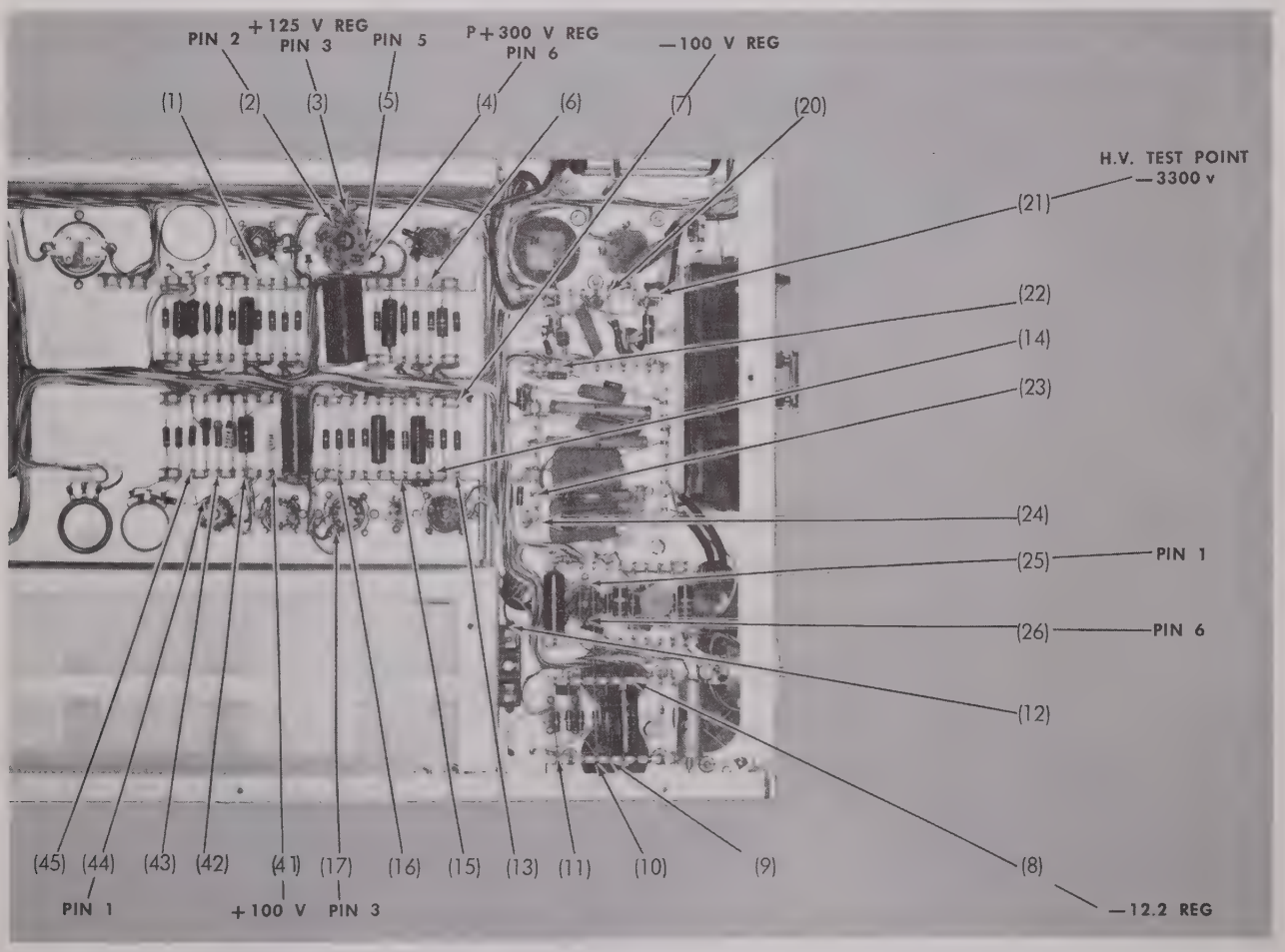


Fig. 4-3. Power-Supply test points (1) through (17). CRT Circuit test points, (20) through (26). Calibrator test points (41) through (45).

Circuit Troubleshooting

In troubleshooting a circuit, broken wires, worn switches, scorched parts, and improperly seated tubes can be found by visual inspection. (Before a scorched part is replaced, the cause of the scorching should be eliminated.)

Tube failure is the most prevalent cause of trouble in Tektronix instruments. Therefore, if a visual check fails to reveal the cause of trouble, all tubes should be checked as the next step. Tubes should be checked by substitution, one at a time. (Tube-testers cannot adequately check all parameters.) Be sure to return all good tubes to their original sockets; otherwise the instrument may have to be recalibrated unnecessarily because of different characteristics of the same tube type.

If tube substitution does not correct the trouble, then check the rest of the circuit by voltage and resistance measurements. Voltages at various test points throughout the instrument are indicated on the schematics. The test points can easily be located using Fig. 4-3. The voltages at the test points are typical and may vary considerably from instrument to instrument. Resistance measurements in a circuit will usually be point-to-point checks for which the proper values can be approximated from the schematic diagrams. Table 4-1 may be used as an aid in relating trouble symptoms to the probable cause and the procedure to use to locate the defective component. Voltages listed in the table were obtained with the Type RM561A operated without plug-in units.

All signal wiring in the Type RM561A is colored to make circuit tracing easier. In addition, all regulated power supply leads are color coded to follow the standard EIA code. The first color (widest stripe) indicates the first number of the voltage. The second color indicates the second and the third color (smallest stripe) indicates the multiplier. The voltage is positive if the main color of the wire is white and negative if the main color of the wire is tan. Four colors would be required to indicate all the digits plus a multiplier for the +125-volt leads. To avoid this, the +125-volt leads are coded as +120; that is, brown, red, brown on a white base. A —100-volt lead is coded brown, black, brown on a tan base while +300-volt leads are coded orange, black, brown on white.

The switch wafer shown on the Calibrator diagram is coded. The letters F and R indicate whether the front or rear of the wafer is used to perform the particular switching function.

TABLE 4-1

RM561A Troubleshooting Table

Symptoms	Checks
	—100-Volt Supply (Any change in this supply may change instrument calibration.)
1. Incorrect output level, ripple, or regulation.	a. Check line voltage. b. Check Setting of —100 volts adjustment (see Calibration Procedure). c. Check V609, V634, V627 and Q624 by substitution. d. If output still incorrect go to whichever symptoms apply of 2 through 7.
2. Output voltage high (too negative).	a. Check voltage at test point (14): about —80 vdc. (Incorrect: check V634B grid circuit components.) b. Measure V634 bias, between pin 7 of V609 and pin 8 of V634: about 2 v. Use meter that can be elevated. (If bias is excessive check R618 and R616.) c. Check R618, R616, R634, R633, and R624.
3. Output voltage low (too positive).	a. Check voltage between pins 17 and 18 of T601. 137 vac ±10% check T601 primary circuit.) b. Check voltage between C640A terminals: about 175 vdc ±10%. (Incorrect: check C640A, C640B, R640, and D640.) c. Check test point (14): about —80-vdc. (Incorrect: check V609.) d. Check R617, R616, C616, C640B.
4. Poor regulation at either high, low or normal line voltage. (Supply should hold regulation within ±1% throughout normal line voltage range.)	a. Check for correct output voltage before checking regulation—also, check output voltage after regulation trouble is fixed. b. Check voltage at test point (17): about +85 vdc. (Voltage low: check D640 and do checks 2A, 2B, and 2C.) c. Check for excessive loading by either plug-in unit or RM561A circuits.
5. Poor regulation at low line voltage.	Check R635, R628 and shunt resistors in plug-in unit.
6. Poor regulation at high line voltage.	Substitute another plug-in unit. (Symptom occurs if load is reduced while shunt resistor remains the same in plug-in unit.)
7. Excessive ripple.	a. Check for correct output voltage and regulation before checking ripple—also check output voltage and regulation after ripple trouble is fixed. b. Check voltage at test point (17): about +85 vdc. c. Check ripple at test point (17): should be less than 25 v peak-to-peak with load. (Excessive: check C640A and D640.) d. Check tubes. e. Check C616, C611, C640A and C640B.
	+125-Volt Supply (Any change in this supply may change instrument calibration.)
8. Incorrect output level, ripple, or regulation.	a. Check line voltage. b. Check —100 volt supply voltage and ripple at test point (7). c. Check setting of +125 VOLTS ad-

Symptoms	Checks
	justment (see Calibration Procedure). d. Check V654, V667. e. If output still incorrect go to whatever symptoms apply of steps 9 through 14.
9. Output voltage high.	a. Check voltage at test point (1): about +68 vdc. (Incorrect: check R657, R658, and V654.) b. Check R650.
10. Output voltage low.	a. Check voltage between pins 19 and 20 of T601: 160 vac ±10%. (Incorrect: check primary circuit.) b. Check voltage at test point (2): +215 vdc. (Incorrect: check C642A, R642, D642.) c. Check test point (1): about +68 vdc. (Incorrect: check R659, V654.) d. Check C650, R651.
11. Poor regulation at either high, low or normal line. (Supply should hold regulation within 1% throughout normal line voltage range.)	a. Check for correct output voltage before checking regulation — also, check output voltage after regulation trouble is fixed. b. Check tubes. c. Check voltage at test point (2): about +215 vdc. (Incorrect: do checks 10A and 10B.)
12. Poor regulation at low line voltage.	Check R653, C650, R666, and shunt resistors in plug-in units.
13. Poor regulation at high line voltage.	a. Check C650. b. Substitute another plug-in unit. (Symptom occurs if load is reduced while shunt resistor remains the same in plug-in unit.)
14. Excessive ripple.	a. Check for correct output voltage and regulation before checking ripple —also, check output voltage and regulation after ripple trouble is fixed. b. Check tubes. c. Check voltage at test point (2): about +215 vdc. (Incorrect: do checks 10A and 10B.) d. Check voltage at test point (1): about +68 vdc. (Incorrect: check R657, R659, R658.) e. Check C642A, and B, C650, D642.
+300-Volt Supply Symptoms and checks similar to those described for the +125 volt supply.	
—12.2-Volt Supply (Any change in this supply may change instrument calibration.)	
15. Incorrect output level, ripple or regulation.	a. Check line voltage. b. Check —100 volt supply output test point (7). c. Check setting of —12.2 VOLTS adjustment (see Calibration Procedure).
	d. Check Q734, Q744, Q757, and F720. e. If output still incorrect go to whichever symptoms apply to steps 16 through 20.
16. Output high (too negative).	a. Check test point (9): about —12 vdc. (Incorrect: check C732, R732.) b. Check test point (10): about +7.9 vdc. (Incorrect: check R734, C737.) c. Check C737, R734, R744.
17. Output low or zero, (too positive).	a. Check voltage between pins 14 and 15 then 15 and 16 of T601: 15 vac ±10% with 117 (234) vac line. (Incorrect: check transformer primary circuit.) b. Check voltage between C720A and B terminals, test points (8) and (12): about 18 vdc. (Incorrect: check C720A, C720B, D720, D721.) c. Check voltage at fuse F720: about +8.2 vdc. (Incorrect: check C757 and F720.) d. Check test point (9): about —12 vdc. (Incorrect: check R731.) e. Check test point (10): about +7.9 vdc. (Incorrect: check R735.) f. Check C757.
18. Poor regulation at either high, low or normal line voltage. (Supply should hold regulation within ±1% throughout normal line voltage range.)	a. Check for correct output voltage before checking regulation — also, check output voltage after regulation trouble is fixed. b. Check for excessive loading by either plug-in units or RM561A circuits.
19. Poor regulation at low or high line voltage.	Check R734, R735, R744, and C737.
20. Excessive Ripple.	a. Check for correct output voltage and regulation before checking ripple —also, check output voltage and regulation after ripple trouble is fixed. b. Check ripple at test point (12): should be less than 4 v peak-to-peak with load. (Excessive: do checks 17A and B.) c. Check D720, D721, C720A and B, C732, C757.
CRT Circuit (Any change in this circuit may change display vertical and horizontal calibration.)	
21. Any incorrect operation of CRT circuit.	a. Check line voltage. b. Check HIGH VOLTAGE adjustment, (—3300 volts at test point (21), see Calibration Procedure). If minor adjustment restores operation circuit may be normal. c. Check V822 and V832 heaters for color: dull orange—normal

Symptoms	Checks
	bright—heavy load on either tube dim—poor tube (replace) both dark—oscillator inoperative d. If operation still incorrect, go to whichever symptoms apply of 22 through 29.
22. Low intensity.	a. Check intensity control setting. b. Check V822 and R835. c. Unblanking pulse doesn't return pin 6 of crt fully to +125 v. d. Check crt.
23. High intensity.	a. Check intensity control setting. b. Check R833, C837, C830 and C832.
24. No intensity.	a. Check intensity control setting. b. Make sure spot or trace is not deflected off screen. (Spot should appear near center with both plug-in units removed.) c. V822 heater open, (B856 and B857 glowing brightly show V822 open). If V822 is open check V814A. d. Check oscillator tubes and circuit including T801. e. Check C822, C842 and crt.
25. Poor astigmatism and/or focus.	a. Check FOCUS and ASTIG. control settings. b. Check HIGH VOLTAGE at pin 2 of crt, test point (20): —3300 vdc. (Incorrect: check R852). c. Check voltage at pin 9 of crt: 0 to +300 vdc when ASTIG. control is rotated. (Incorrect: check R864 and +300 vdc to R864.)
26. Blooming (size of display increases with intensity increase).	Check V800 and V822 (either may be weak).
27. No intensifying pulse.	a. D838 shorted, D839 open. b. C837 or R837 open (leading edge of long intensifying pulse missing).
28. No Z-axis modulation or no chopped blanking.	C853 or R853 open. If R853 open check for shorted C853.
29. Intensity varies (unwanted Z-axis modulation).	D838 and/or D839 open.
CALIBRATOR	
30. Incorrect outputs.	a. Check CAL. AMPL. adjustment (see Calibration Procedure). b. Check V884. c. Check voltages at test points (41 through 45). d. Use Calibration Procedure, check divider in V884B cathode.

SECTION 5

PERFORMANCE CHECK

Introduction

This section of the manual provides a means of rapidly checking the performance of the Type RM561A. It is intended to check the calibration of the instrument without the need for performing the complete Calibration Procedure. The Performance Check does not provide for the adjustment of any internal controls. Failure to meet the requirements given in this procedure indicates the need for internal checks or adjustments, and the user should refer to the Calibration Procedure in this manual.

Recommended Equipment

The following equipment is recommended for a complete performance check. Specifications given are the minimum necessary to perform this procedure. All equipment is assumed to be calibrated and operating within the original specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For the most accurate and convenient performance check, special calibration fixtures are used in this procedure. These calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Tektronix 2- or 3-series amplifier plug-in unit.[1]

2. Tektronix 2- or 3-series time-base plug-in unit.[1]

3. Variable autotransformer. Must be capable of supplying at least 350 volt-amperes over a voltage range of 105 to 125 volts (210 to 250 volts for 234-volt nominal line). For example, General Radio W10MT3 Metered Variac Autotransformer.

4. Test oscilloscope. Frequency response, 10 MHz; minimum deflection factor, 0.005 volts/division. Tektronix Type 561A/RM with Type 3A1 and 2A63 Amplifier Plug-Ins and Type 3B4 Time-Base Plug-In recommended.

5. CRT deflection capacitance normalizer. Tektronix Calibration Fixture, 067-0500-00, recommended.

6. Standard amplitude calibrator. Amplitude accuracy, 0.25%; signal amplitude, 50 millivolts to 100 volts; output signals, 1-kHz square-wave. Tektronix Calibration Fixture, 067-0502-00, recommended.

7. Time-mark generator. Marker outputs, 1 μs and 100 μs; accuracy 0.001%. Tektronix Type 184 Time-Mark Generator recommended.

8. Termination. Impedance, 50-ohm; accuracy, $\pm$3%; connectors, BNC. Tektronix Part No. 011-0049-00.

9. Cable (two). Impedance, 50-ohm; connectors, BNC. Tektronix Part No. 012-0057-00.

10. Patch cord. Length, 18-inch; connectors, BNC-to-banana plug. Tektronix Part No. 012-0091-00.

[1]**Use maximum performance plug-in units. .For example, use a high-frequency unit in performance to low-frequency, dual-trace rather than single-trace, etc.**

11. Patch cord. Length, 18-inch; connectors, BNC-to-BNC. Tektronix Part No. 012-0087-00.

PERFORMANCE CHECK PROCEDURE

General

In the following procedure, test equipment connection or control settings should not be changed except as noted. If only a partial check is desired, refer to the preceding step(s) for setup information.

The following procedure uses the equipment listed under Recommended Equipment. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. Insert the amplifier plug-in in the left plug-in compartment.

2. Insert the time-base plug-in unit in the right plug-in compartment.

3. Connect the autotransformer to a suitable power source.

4. Connect the Type RM561A to the autotransformer output.

5. Set the autotransformer to 115 (or 230) volts.

6. Set the Type RM561A POWER switch to ON. Allow at least 20 minutes warm up for checking the instrument to the given accuracy. Set the following controls:

Type RM561A

FOCUS	Any position
INTENSITY	Midrange
CALIBRATOR	OFF
SCALE ILLUM	Clockwise
CRT CATHODE SELECTOR	Normal

Amplifier Unit

Position	Midrange
Ac Dc Gnd	Ac
Volts/Division	1
Variable	Calibrated

Time-Base Unit

Position	Midrange
Magnifier	Off
Time/Division	1 millisecond
Variable	Calibrated
Triggering controls	Adjusted for free running trace

1. Check CRT for Double Peaking

a. Requirement—There should be a constant increase in trace intensity as each INTENSITY control is rotated clockwise. All signs of double peaking must be gone within 3 minutes.

b. Turn the INTENSITY control counterclockwise and then slowly clockwise.

c. Check—For a constant increasing brightness of the trace. If the trace brightens, then decreases intensity and then constantly brightens again it is double peaking.

d. Turn the INTENSITY control counterclockwise from its fully clockwise position.

e. Check—For a constantly decreasing brightness. If the trace brightness decreases, then increases and then decreases once more, this again is double peaking.

f. Readjust the INTENSITY control for a usable trace brightness.

2. Checking Calibrator

a. Requirement—The signal amplitude accuracy must be within 3% of the indicated peak-to-peak amplitude except at the .1 V INTO 50 Ω where it is ±3.5% when terminated with 50 ohms. The symmetry must be within ±20% of being a 50% duty cycle and the risetime must not exceed 6 μs.

b. Set the test oscilloscope Volts/Div switch to 10.

c. Connect a 50-ohm coaxial cable from the test oscilloscope vertical input connector to the Output of the standard amplitude calibrator.

d. Connect a second 50-ohm coaxial cable from the Unknown Input of the standard amplitude calibrator to the CAL OUT connector of the Type RM561A.

e. Set the Mode switches of the standard amplitude calibrator to Square-Wave and Mixed.

f. Set the CALIBRATOR to 100 VOLTS.

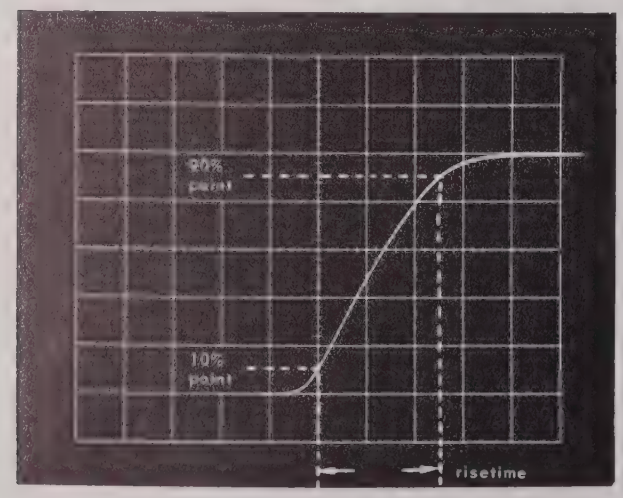


Fig. 5-1. Measuring risetime.

g. Using Table 5-1, switch the Amplitude control of the standard amplitude calibrator and the CALIBRATOR control of the Type RM561A simultaneously to each setting listed in the table.

h. Check—Top of the mixed square-wave presentation noting the amount of trace separation. The trace separation noted must not exceed the amount listed in Table 5-1.

TABLE 5-1

Calibrator Switch Settings	Test Oscilloscope Volts/Div switch Settings	Maximum Trace Separation
100 Volts	10	3 mm
50 Volts	5	3 mm
20 Volts	2	3 mm
10 Volts	1	3 mm
5 Volts	.5	3 mm
2 Volts	.2	3 mm
1 Volt	.1	3 mm
.5 Volt	.05	3 mm
.2 Volt	.02	3 mm
.1 Volt	.01	3 mm
50 mVolts	.005	3 mm

i. Set the standard amplitude calibrator Amplitude control to .1 Volt and the Type RM561A CALIBRATOR control to .1 V INTO 50 Ω.

j. Disconnect the 50-ohm coaxial cable from the Type RM561A CAL OUT connector.

k. Connect a 50-ohm termination to the CAL OUT connector, then connect the 50-ohm coaxial cable that was removed in part j to the 50-ohm termination.

l. Set the test oscilloscope Volts/Div switch to .01.

m. Check—For not more than 3.5 mm of trace separation.

n. Remove the coaxial cables and the 50-ohm termination connections.

o. Connect a 50-ohm coaxial cable from the Type RM561A CALIBRATOR to the test oscilloscope vertical input connector.

p. Set the CALIBRATOR for a two-volt output.

q. Adjust the test oscilloscope Volts/Div and Position controls to obtain a 4-cm high display centered about the center horizontal graticule line.

r. Set the Time/Div switch to 1 ms and the Triggering Level control for a stable display.

s. Adjust the test oscilloscope Horizontal Position control and Time/Div Variable control until one complete cycle of the square-wave presentation occupies the center 8 cm of the graticule.

t. Check—The width, in centimeters, of the positive-going portion of the square-wave presentation. The width should not be less than 3.2 cm nor more than 4.8 cm for a square-wave whose duty cycle is 50% ±20%.

u. Return the Time/Div Variable control to its Calibrated position and set the Time/Div switch to 1 μs.

v. Position the rising portion of the display to the center vertical graticule line with the Horizontal Position control.

w. Check—The risetime (see Fig. 5-1). The risetime should not exceed 6 μs.

x. Remove the coaxial cable and set the Type RM561A CALIBRATOR to OFF.

3. Graticule Scale Illumination

a. Requirement—There should not be any flickering of the graticule scale illumination as the SCALE ILLUM control is rotated throughout its range. When the SCALE ILLUM control is fully counterclockwise there should be no illumination, and with the control fully clockwise there should be maximum illumination.

b. Set the SCALE ILLUM control fully counterclockwise.

c. Check—For no graticule illumination.

d. Check—That as the control is slowly rotated clockwise the graticule illumination does not flicker.

e. Check—For maximum graticule illumination when the control has been rotated to its fully clockwise position.

f. Set the SCALE ILLUM control for a usable graticule illumination level.

4. Trace Alignment

The trace should be parallel to the horizontal graticule lines, but due to the different effects that the earth's magnetic field will have at various locations, it is impossible to state that the trace should be aligned within plus or minus a specific tolerance.

If the trace is not parallel to the horizontal graticule lines it will be necessary to adjust the ALIGNMENT control until the trace is parallel to the horizontal graticule lines.

5. Horizontal Position Control

a. Requirement—Clockwise rotation of the control should move the trace smoothly to the right, while counterclockwise rotation of the control should move the trace smoothly to the left.

b. Rotate the horizontal position control clockwise.

c. Check—That the trace moved smoothly to the right.

d. Rotate the horizontal position control counterclockwise.

e. Check—That the trace moved smoothly to the left.

f. Return the horizontal position control to its midrange position.

6. High-Voltage Regulation

a. Requirement—High-voltage supply should regulate (no spot blooming) between the high and low line voltages that the Type RM561A has been designed to operate from.

b. Set the autotransformer for the low-line voltage 105 volts for 115 volts line voltage or 210 volts for 230 volts line voltage.

c. Rotate the FOCUS control fully clockwise.

d. Position the spot onto the graticule area with the positioning controls.

e. Rotate the INTENSITY control from its normal position to its fully clockwise position.

f. Check—For blooming (see Fig. 5-1).

g. Return the INTENSITY control to normal position.

h. Set the autotransformer for the high-line voltage 125 volts for 115 volts line voltage or 250 volts for 230 volts line voltage.

i. Rotate the INTENSITY control fully clockwise from its normal position.

j. Check—For blooming (see Fig. 5-2).

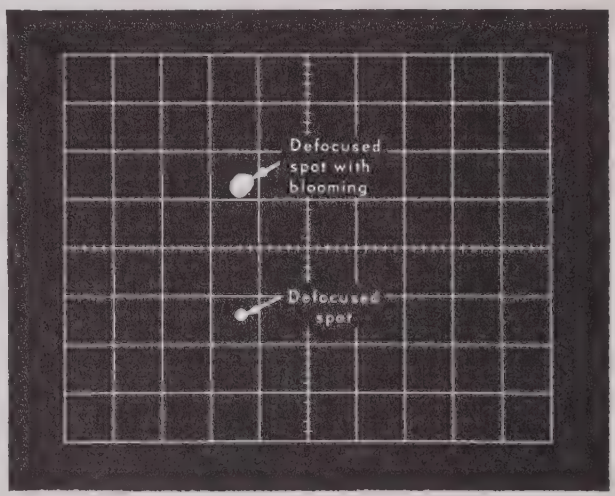


Fig. 5-2. Checking CRT display for spot blooming (high-voltage not in regulation).

k. Return the INTENSITY control to its normal position and the autotransformer to the design center line voltage, 115 volts or 230 volts.

l. Readjust the FOCUS control for the best focus.

7. Vertical Geometry

a. Requirement—The vertical display lines must not deviate more than 2 mm from being parallel to the vertical graticule lines.

b. Set the Time/Div switch of the time base plug-in to 1 ms.

c. Connect a 50-ohm coaxial cable from the Type 184 Marker Out connector to the amplifier plug-in input connector.

d. Apply 1 μs time markers from the Type 184 and adjust the display amplitude so the time markers extend beyond the graticule limits.

e. Adjust the vertical positioning control to move the bottom of the time marker display out of the display area.

f. Adjust the FOCUS control for the best focus.

g. Check—That the vertical time marker lines are within 2 mm of being parallel to the vertical graticule line. The time markers are 1 mm apart.

h. Remove the coaxial cable.

8. Horizontal Geometry

a. Requirement—The horizontal display lines must not deviate more than 2 mm from being parallel to the horizontal graticule lines.

b. Set the Time/Div switch of the time base plug-in to 0.1 ms and cause the trace to free run.

c. Set the amplifier plug-in Volts/Div switch to .5.

d. Connect 100 mVOLTS of CALIBRATOR signal through 50-ohm coaxial cable to the input connector of the amplifier plug-in.

e. With the vertical position control, place the display of two parallel lines to the horizontal center graticule line.

f. With the vertical position control place the bottom line of the two-line display upon the top graticule line.

g. Check—For not more than 2 mm of trace deviation in a horizontal distance of 10 cm. The lines of the two-line display are 2 mm apart.

h. With the position control place the top line of the two-line display upon the bottom graticule line.

i. Check—For not more than 2 mm of trace deviation in a horizontal distance of 10 cm. The lines of the two-line display are 2 mm apart.

j. Disconnect the coaxial cable.

9. Focus and Astigmatism

a. Requirement—That individual vertical time markers 1 mm apart can be distinguished within the graticule area when the FOCUS control has been properly adjusted. The FOCUS control when properly adjusted must not be at either end of adjustment range.

b. Set the Time/Div switch time base of the plug-in to 1 ms.

c. Apply 100-μs time markers from the Type 184 through a 50-ohm coaxial cable to the input connector of plug-in amplifier.

d. Adjust the display amplitude so the time markers go beyond the graticule area.

e. Adjust the vertical position control so the bottom of the time markers is positioned out of the viewing area.

f. Adjust the triggering controls of the time base plug-in for a stable display.

g. Adjust the FOCUS control for the best focus throughout the graticule area.

h. Check—That the individual vertical time markers 1 mm apart can be distinguished anywhere within the graticule area.

i. Check—That the FOCUS control when adjusted is not at either end of its range.

j. Remove the coaxial cable.

10. Vertical and Horizontal CRT Deflection-Plate Compensation

a. Requirement—Optimum square corner must be obtained with the CRT Deflection Capacitance Normalizer for both the vertical and the horizontal plug-in compartments.

b. Remove the amplifier plug-in from the left plug-in compartment.

c. Insert the CRT Deflection Capacitance Normalizer into the left plug-in compartment.

d. Connect 100 VOLTS of CALIBRATOR signal through a 50-ohm coaxial cable to the Capacitance Normalizer input connector.

e. Adjust the time-base plug-in triggering controls so the leading edge of the waveform is displayed.

NOTE

The INTENSITY control may need to be advanced slightly to view the leading edge of the waveform.

f. Check—For optimum square corner (see Fig. 5-3A).

g. Interchange the Capacitance Normalizer and the time-base plug-in. Readjust the FOCUS control and the time-base plug-in triggering controls for a stable well-focused display.

h. Check—For optimum square corner (see Fig. 5-4).

i. Disconnect the coaxial cable.

j. Remove the Capacitance Normalizer. Replace the amplifier plug-in in the left compartment and the time-base plug-in in the right compartment.

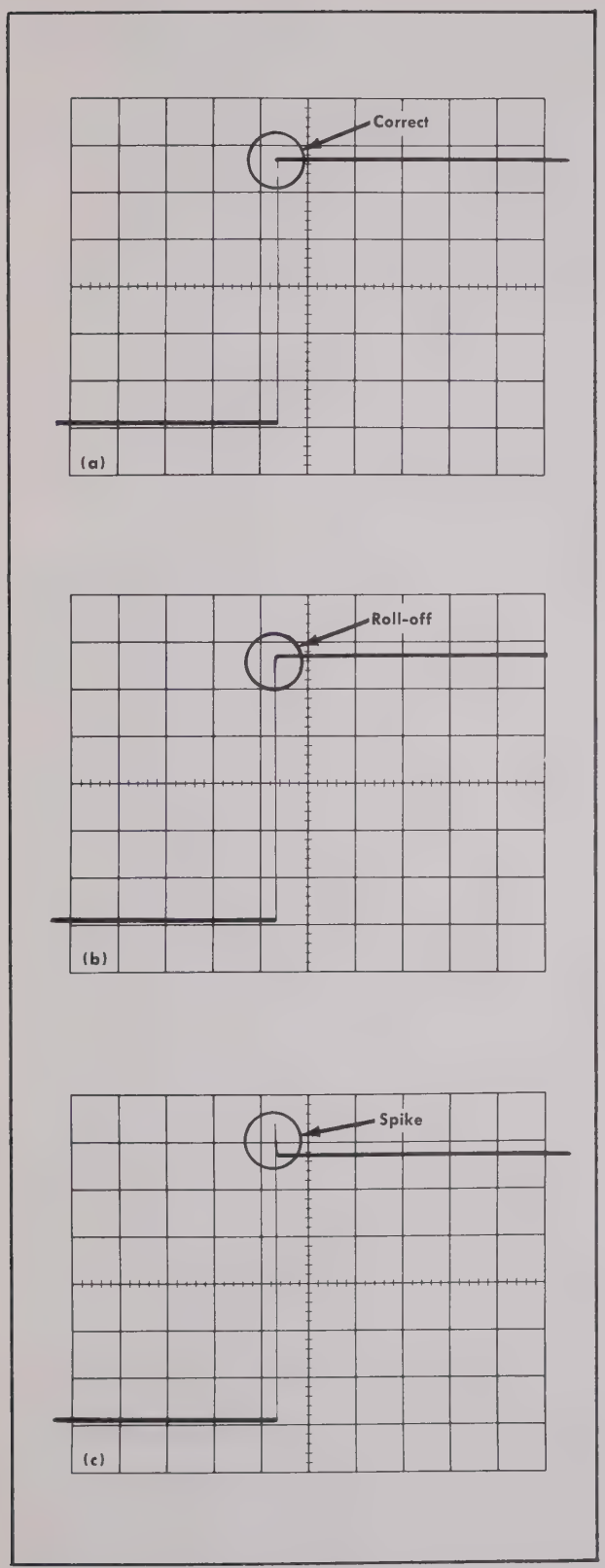


Fig. 5-3. (A) Typical CRT display showing correct vertical compensation adjustment, (B) and (C) incorrect adjustment.

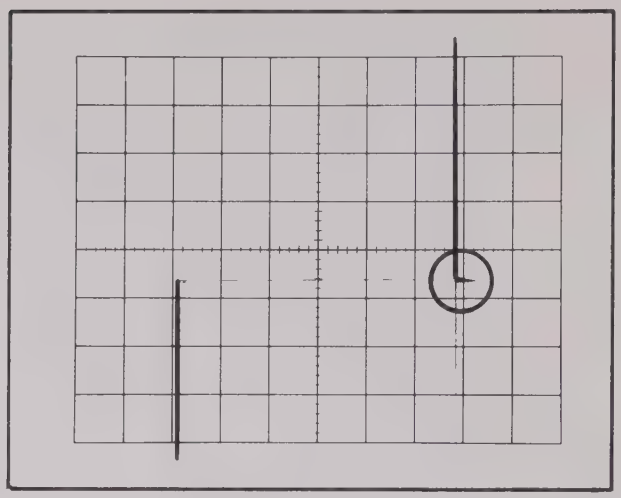


Fig. 5-4. Typical CRT display showing correct adjustment of horizontal compensation.

11. Alternate Trace and Chopped Blanking

a. Requirement—In the alternate mode two traces must show for the vertical plug-in at all sweep rates (TIME/CM switch settings).

In chopped mode the chopping transients (rising and falling portions of the waveform) must be blanked out.

NOTE

This check can only be made with an amplifier plug-in which has both alternate trace and chopped blanking provisions.

b. Set the amplifier plug-in Mode switch to Alter.

c. Set the amplifier plug-in Ac-Dc Gnd switches to Gnd.

d. Position the traces about three divisions apart.

e. Rotate the Time/Div switch of the time base plug-in throughout its range.

f. Check—For an alternating two-trace display at all sweep rates.

g. Set the amplifier plug-in Mode switch to Chop.

h. Position the two traces about three divisions apart.

i. Set the time-base plug-in Time/Div switch to display several cycles of the waveform and adjust the triggering controls for a stable display.

j. With the CRT CATHODE SELECTOR switch in the Normal position, notice the overshoot on the display (see Fig. 5-5A).

k. Set the CRT CATHODE SELECTOR switch to CHOPPED BLANKING.

l. Check—That the between-channel switching transients are removed from the display (see Fig. 5-5B).

m. Set the amplifier plug-in Mode switch to display only one channel.

n. Set the CRT CATHODE SELECTOR switch in the Normal position.

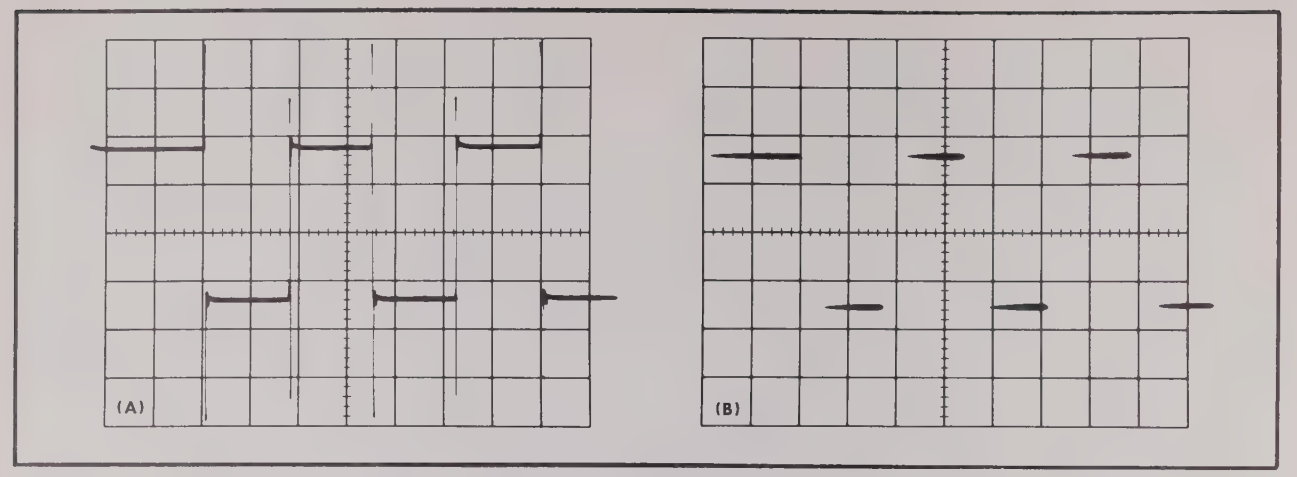


Fig. 5-5. Alternate waveform showing (A) unblanked chopping transients and (B) blanked transients.

12. CRT Intensifier Circuit

a. Requirement—A portion of the trace must appear brighter (intensified) than the rest of the trace. The intensified portion of the trace should move along the trace as the delay time control is rotated.

NOTE

This check can only be made with a time-base plug-in which has delayed sweep provisions.

b. Set the time-base plug-in Time/Div switch to 1 ms and the time-base plug-in delayed sweep Time/Div switch to 0.1 ms.

c. Adjust the time-base plug-in triggering controls to produce a trace.

d. Adjust the FOCUS control and the time-base plug-in triggering controls for a well-focused free-running (or automatic triggered) trace.

e. Turn the time-base plug-in Mode switch to Intensified (not triggered).

f. Check—That an intensified portion appears on the trace (see Fig. 5-6). If the display appears only as a shortened trace, increase the INTENSITY control slightly until the complete trace, showing an intensified portion, appears.

g. Check—That as the delay time control is rotated throughout its range the intensified portion moves along the trace.

h. Set the time-base plug-in Mode switch for a normal sweep and the triggering controls for a free running trace.

13. Intensity (Z-Axis) Modulation

a. Requirement—The trace can be modulated when 10 volts or more of signal is applied to the EXT CRT CATHODE connector.

b. Remove the ground strap between the rear-panel banana jacks.

c. Set the CALIBRATOR for a 10-volt output signal.

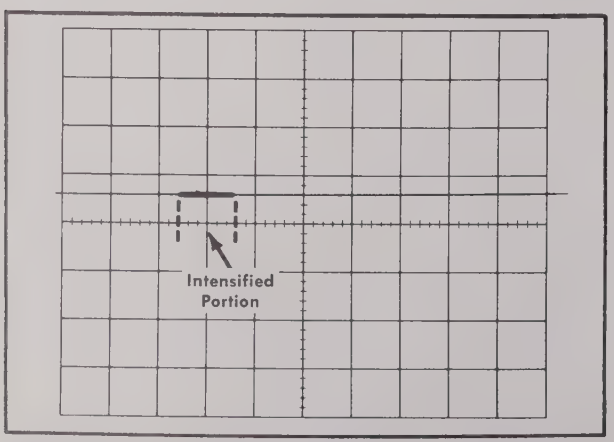


Fig. 5-6. Typical CRT display showing correct intensifier circuit operation.

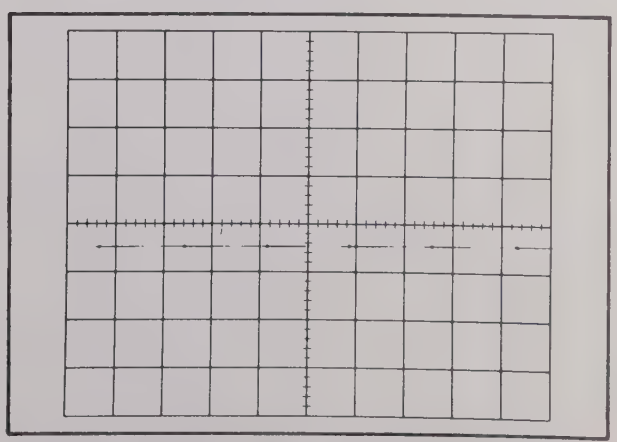


Fig. 5-7. Typical CRT display showing correct intensity modulation (time/division, 10 milliseconds).

d. Connect the CALIBRATOR signal to the EXT CRT CATHODE banana jack with the BNC-to-BNC and BNC-to-banana jack jumper leads.

e. Check—The display for intensified dots (see Fig. 5-7). It may be necessary to reduce the INTENSITY setting slightly to see the dots.

f. Remove the jumper leads and replace the ground strap.

This completes the Performance Check of the Type RM561A. Disconnect all test equipment. The plug-in amplifier and time-base plug-in are checked separately.

NOTES

SECTION 6

CALIBRATION

Introduction

Complete calibration information for the Type RM561A is given in this section. This procedure checks the instrument against the performance requirements listed in the Characteristics section. The Type RM561A can be returned to original performance standards by completion of each step in this procedure. If it is desired to merely touch up the calibration, perform only those steps entitled "Adjust . . .". A short-form calibration procedure is also provided in this section for the convenience of the experienced calibrator. It may also be used as a calibration record or as an index to the steps in the complete Calibration Procedure.

The Type RM561A should be checked, and recalibrated if necessary, after 500 hours of operation, or every six months if used infrequently, to assure correct operation and accuracy.

EQUIPMENT REQUIRED

The following test equipment (shown in Figs. 6-1 and 6-2), or its equivalent, is required for complete calibration of the Type RM561A. Specifications given are the minimum necessary for accurate calibration of this instrument. All test equipment is assumed to be correctly calibrated and operating within the given specifications. If equipment is substituted, it must meet or exceed the specifications of the recommended equipment.

For the quickest and most accurate calibration, special calibration fixtures are used where necessary. All calibration fixtures listed here can be obtained from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

1. Tektronix 2- or 3-series amplifier plug-in unit.[1]

2. Tektronix 2- or 3-series time base plug-in unit.[1]

3. DC voltmeter. Minimum sensitivity, 20,000 ohms/volt; accuracy, checked to 1% at —100 volts, —12.2 volts, +125 volts and +300 volts and ±3% at —3300 volts. For example, Simpson Model 262.[2]

4. Variable autotransformer. Must be capable of supplying at least 350 volt-amperes over a voltage range of 105 to 125 volts (210 to 250 volts for 230-volt nominal line). For example, General Radio W10MT3W Metered Variac Autotransformer.[3]

5. Test oscilloscope. Frequency response, 10 MHz; minimum deflection factor, 0.005 volts/division. Tektronix 530-, 540-series Oscilloscope with Type B Plug-In Unit or Tektronix Type 561A/RM with Type 3A1 and 2A63 Amplifier Plug-Ins and Type 3B4 Time-Base Plug-In recommended.

6. CRT deflection capacitance normalizer. Tektronix Calibration Fixture 067-0500-00 recommended.[4]

7. Standard amplitude calibrator. Amplitude accuracy, 0.25%; signal amplitude, 0.2 millivolts to 100 volts; output signals, 1-kHz square-wave and +DC. Tektronix Calibration Fixture 067-0502-00 recommended.

8. Termination. Impedance, 50-ohm; connectors, GR; accuracy, ±0.1%. Tektronix Calibration Fixture 067-0515-00.

9. 1× probe. BNC Connector. Tektronix P6028 Probe.

10. Cable (three). Impedance, 50-ohm; connectors, BNC. Tektronix Part No. 012-0057-00.

11. Patch cord. Length, 18 inches; connectors, BNC-to-banana plug. Tektronix Part No. 012-0091-00.

12. Patch cord. Length, 18 inches; connectors, BNC-to-BNC. Tektronix Part No. 012-0087-00.

13. Adjustment tool. Insulated screwdriver, non-metallic. Tektronix Part No. 003-0000-00.

14. Adapter. GR to BNC female. Tektronix Part No. 017-0063-00.

15. Adapter. GR to BNC male. Tektronix Part No. 017-0064-00.

16. Jumper lead (not shown). Length, 6 inches; connectors, insulated alligator clips. Not available from Tektronix.

CALIBRATION RECORD AND INDEX

This short-form calibration procedure is provided to aid in checking the operation of the Type RM561A. It may be used as a calibration guide by the experienced calibrator, or it may be used as a record of calibration. Since the step numbers and titles used here correspond to those used in the complete Calibration Procedure, this procedure also serves as an index to locate a step in the complete Calibration Procedure. Performance requirements correspond to those given in the Characteristics section.

Type RM561A, Serial No. _____

Calibration Date _____

Calibration Technician _____

[1]Use maximum performance plug-in units. For example, use a high-frequency unit in preference to low-frequency, dual-trace rather than single-trace, etc.

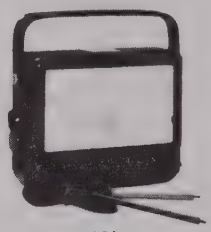
[2]When used with sampling plug-in units. The Type RM561A low-voltage power supplies must be adjusted to 0.5% or better for correct plug-in operation. Use a DC voltmeter with accuracy better than 0.05%.

[3]Used only to check power-supply regulation and ripple in steps 6 and 7. May be deleted from list if these checks are not performed.

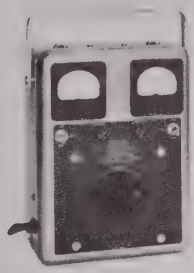
[4]Normally required only if new cathode-ray tube has been installed or if deflection-plate compensation has been inadvertently misadjusted. An alternative method of adjustment is also given in step 16b.

(1)

(2)



(3)



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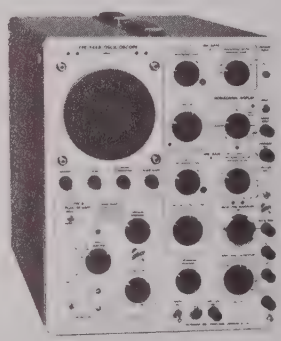


(5)

(6)

(7)

Fig. 6-1. Recommended calibration equipment, items 1 through 7.

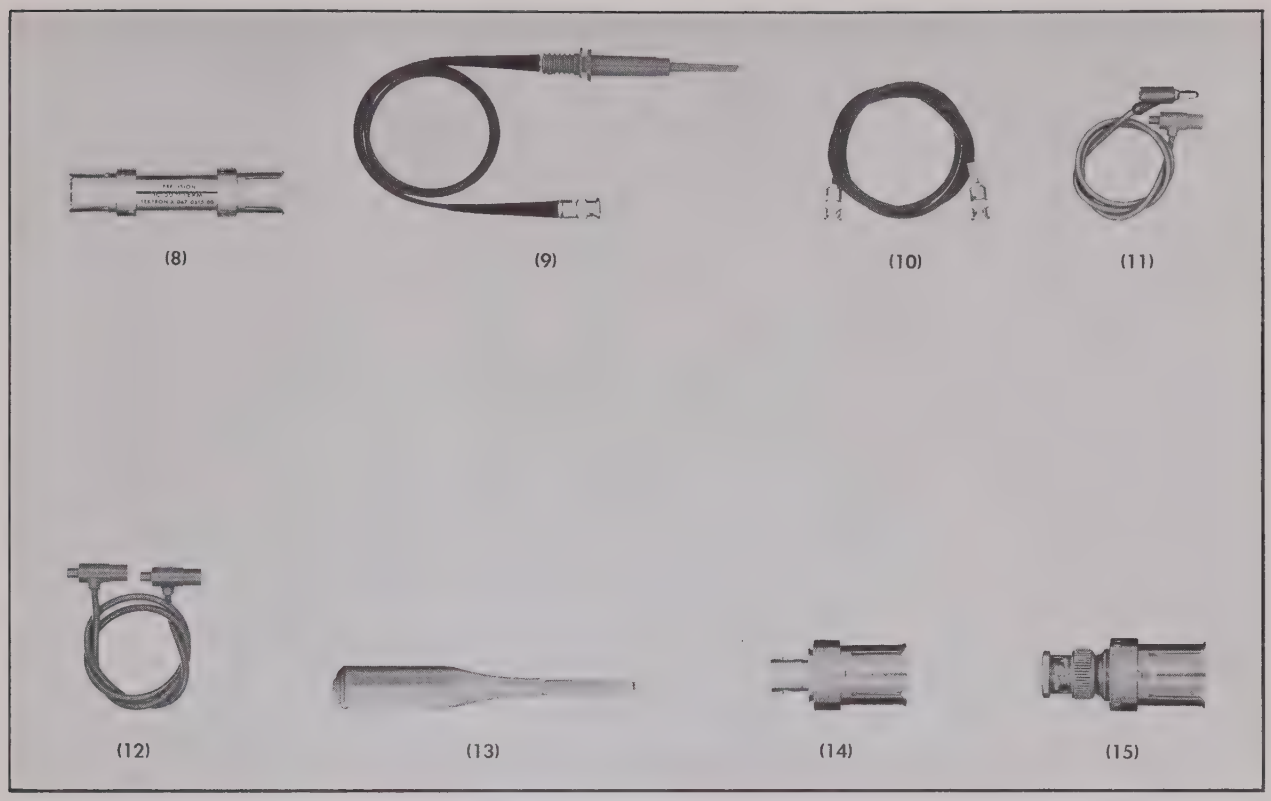


Fig. 6-2. Recommended calibration equipment, items 8 through 15.

☐ 1. Adjust —100-Volt Power Supply (Page 6-5)
—100 volts, ±3 volts.

☐ 2. Adjust +125-Volt Power Supply (Page 6-5)
+125 volts, ±3.8 volts.

☐ 3. Adjust —300-Volt Power Supply (Page 6-6)
+300 volts, ±9 volts.

☐ 4. Adjust —12.2-Volt Power Supply (Page 6-6)
—12.2 volts, ±0.37 volt.

☐ 5. Adjust High-Voltage Power Supply (Page 6-6)
—3300 volts, ±100 volts.

☐ 6. Check Low-Voltage Power Supply Regulation (Page 6-6)

—100 volt	±1 volt
+125 volt	±1.25 volts
+300 volt	±3 volts
—12.2 volt	±0.12 volt

Check regulation at low and high line.

☐ 7. Check High-Voltage Power-Supply Regulation (Page 6-7)
Within ±100 volts at low and high line.

☐ 8. Adjust Calibrator Amplitude (Page 6-8)
+100 volts, ±3 volts.

☐ 9. Check D838-D839 Junction Voltage (Page 6-8)
Less than +0.6 volt DC.

☐ 10. Check Power-Supply Ripple (Page 6-9)

—100 volt	5 millivolts
+125 volt	10 millivolts
+300 volt	80 millivolts
—12.2 volt	3 millivolts
—3300 volt	DO NOT MEASURE

☐ 11. Adjust Astigmatism (Page 6-10)
Sharp, well-defined display.

☐ 12. Adjust Trace Alignment (Page 6-10)
Trace parallel to horizontal graticule lines.

☐ 13. Adjust Cathode-Ray Tube Geometry (Page 6-11)
Best overall geometry.

☐ 14. Check Calibrator Accuracy (Page 6-12)

Within ±3% of indicated voltage.

☐ 15. Check Calibrator Risetime and Symmetry (Page 6-14)

Risetime, less than 6 microseconds; symmetry, 40% to 60%.

☐ 16. Adjust Vertical and Horizontal Deflection-Plate Compensation (Page 6-15)

Optimum square corner (or 14.3 picofarads effective capacitance).

☐ 17. Check Dual-Trace Chopped Blanking (Page 6-17)

Blanking of between channel switching transients (with dual-trace amplifier unit).

☐ 18. Check CRT Intensifier Circuit (Page 6-18)

Intensified portion on trace (with delayed sweep time-base unit).

☐ 19. Check CRT Vertical Sensitivity (Page 6-19)

19.5 volts, ±1 volt.

☐ 20. Check CRT Horizontal Sensitivity (Page 6-19)

18.4 volts, ±0.9 volt.

☐ 21. Check Intensity (Z-Axis) Modulation (Page 6-19)

Intensity modulation with 10 volts input.

CALIBRATION PROCEDURE

General

The following procedure is arranged in a sequence which allows the Type RM561A to be calibrated with the least interaction of adjustments and reconnection of equipment. If desired, the steps may be performed individually or out of sequence. However, some adjustments affect the calibration of other circuits within the instrument. In this case, it will be necessary to check the operation of other parts of the instrument. When a step interacts with others, the steps which need to be checked will be noted.

Any needed maintenance should be performed before proceeding with calibration. Troubles which become apparent during calibration should be corrected using the techniques given in the Maintenance section.

The Adjust . . . ◐ steps in the following procedure provide a check of instrument performance, whenever possible, before the adjustment is made. To prevent recalibration of other circuits when performing a partial calibration, readjust only if the listed tolerance is not met. However, when performing a complete recalibration, best overall performance will be provided if each adjustment is made to the exact setting, even if the CHECK . . . is within the allowable tolerance. The symbol ◐ is used to identify the steps in which an adjustment is made.

In the following calibration procedure, a test equipment setup is shown for each major group of adjustments and checks. Beneath each setup picture is a complete list of front-panel control settings for the Type RM561A. To aid in locating individual controls which have been changed during complete calibration, these control names are printed in bold type. If only a partial calibration is performed, start with the nearest setup preceding the desired portion.

The following procedure uses the equipment listed under Equipment Required. If substitute equipment is used, control settings or setup must be altered to meet the requirements of the equipment used.

Preliminary Procedure

1. If the Type RM561A is mounted in a cabinet rack, pull it out to the fully extended position.

2. Remove the top and bottom covers from the Type RM561A.

3. Insert the amplifier plug-in unit in the left plug-in compartment.

4. Insert the time-base plug-in unit in the right plug-in compartment.

5. Connect the autotransformer to a suitable power source.

6. Connect the Type RM561A to the autotransformer output.

7. Set the autotransformer to 115 (or 230) volts.

8. Set the Type RM561A POWER switch to ON. Allow at least 20 minutes warm up for checking the instrument to the given accuracy.

NOTES

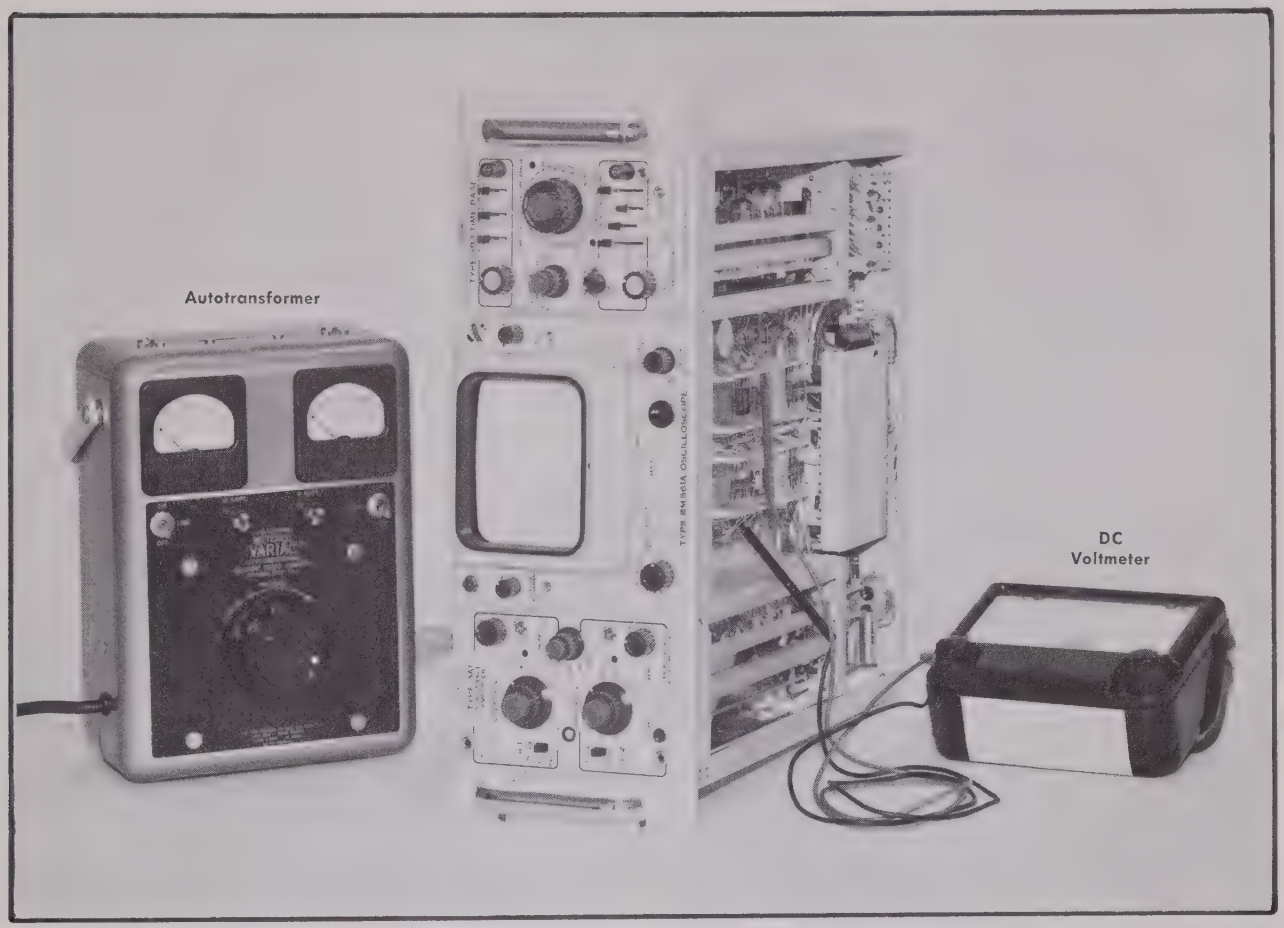


Fig. 6-3. Test equipment setup for power supply adjustments.

Control Settings

Type RM561A

FOCUS	Any position
INTENSITY	Midrange
CALIBRATOR	OFF
SCALE ILLUM	Clockwise
CRT CATHODE SELECTOR	Normal

Amplifier Unit

Position	Midrange
AC DC Gnd	AC
Volts/Division	1
Variable	Calibrated

Time-Base Unit

Position	Midrange
Magnifier	Off
Time/Division	1 millisecond
Variable	Calibrated
Triggering controls	Any Position

1. Adjust —100-Volt Power Supply

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the DC voltmeter from the —100-volt test point (Fig. 6-4A) to chassis ground.

c. CHECK—Meter reading; —100 volts, ±3 volts.

d. ADJUST— —100 V adjustment, R616 (Fig. 6-4B) for —100 Volts.

e. INTERACTION—May affect operation of all circuits within the Type RM561A.

2. Adjust +125-Volt Power Supply

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the DC voltmeter from the +125-volt test point (Fig. 6-4A) to chassis ground.

c. CHECK—Meter reading; +125 volts, ±3.8 volts.

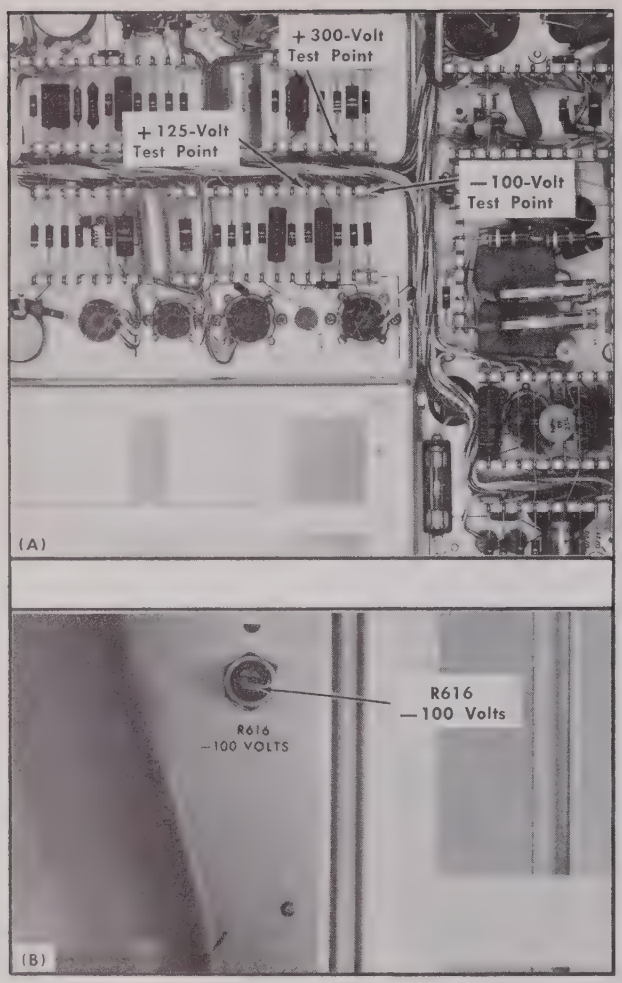


Fig. 6-4. (A) Location of —100-, +125- and +300-volt test points (bottom view), (B) location of —100-volt adjustment (top view).

d. ADJUST—+125 Volts adjustment, R656 (Fig. 6-5), for +125 volts.

e. INTERACTION—May affect operation of all circuits within the Type RM561A.

3. Adjust +300-Volt Power Supply

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the DC voltmeter from the +300-volt test point (Fig. 6-4A) to chassis ground.

c. CHECK—Meter reading; +300 volts, ±9 volts.

d. ADJUST—+300 Volts adjustment, R676 (Fig. 6-5), for +300 volts.

e. INTERACTION—May affect operation of all circuits within the Type RM561A.

4. Adjust —12.2-Volt Power Supply

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the DC voltmeter from the —12.2-volt test point (Fig. 6-6) to chassis ground.

c. CHECK—Meter reading; —12.2 volts, ±0.37 volt.

d. ADJUST—12.2 Volts adjustment, R730 (Fig. 6-5), for —12.2 volts.

e. INTERACTION—May affect operation of all circuits within the Type RM561A.

5. Adjust High-Voltage Power Supply

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the DC voltmeter from the high-voltage test point (Fig. 6-7A) to chassis ground.

c. CHECK—Meter reading; —3300 volts, ±100 volts.

d. ADJUST—High Voltage adjustment, R841 (Fig. 6-7B), for —3300 volts.

e. INTERACTION—Check steps 7, 11-13 and 16.

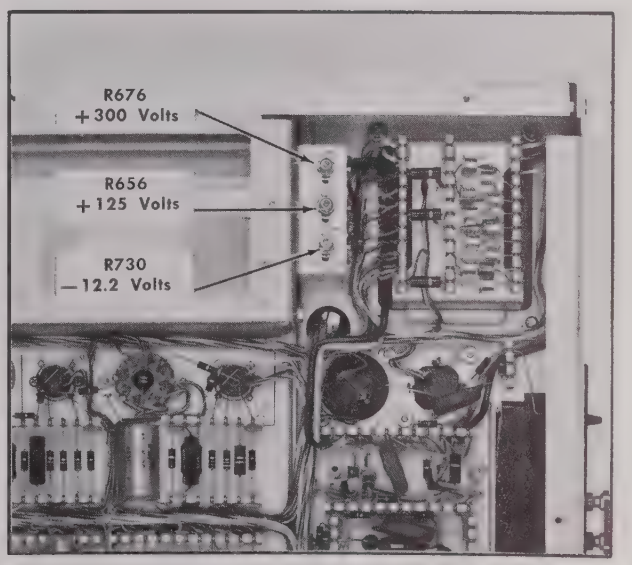


Fig. 6-5. Location of +125-, +300- and —12.2-volt adjustments (bottom view).

6. Check Low-Voltage Power-Supply Regulation

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the DC voltmeter from the —100-volt test point (Fig. 6-4A) to chassis ground.

c. With the autotransformer set to 117 volts (or 234 volts) note the test point voltage.

d. Set the autotransformer to 105 (210) volts and again check the voltage. Voltage should be within 1 volt of reading in step c.

e. Set the autotransformer to 125 (250) volts and check the voltage. Voltage should be within 1 volt of reading in step c.

f. Remove both plug-ins from the instrument (minimum load).

g. With the autotransformer set to 125 (250) volts, the voltage should be within 1 volt of reading in step c.

h. Return the autotransformer to 105 (210) volts and check the voltage. Voltage should be within 1 volt of reading in step c.

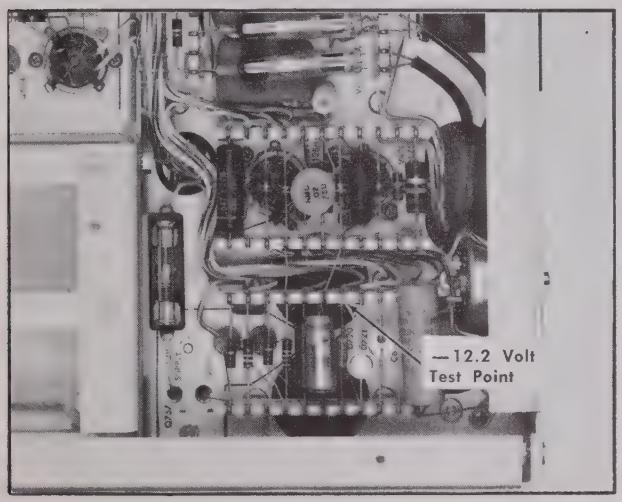


Fig. 6-6. Location of —12.2-volt test point (bottom view).

i. Repeat this procedure for each low-voltage supply. Table 6-1 shows maximum voltage deviation allowable for each supply. Test point locations are shown in Figs. 6-4A and 6-6.

NOTE

A 150-milliamp minimum load current is necessary for proper regulation of the —12.2-volt supply. Minimum-load regulation of this supply can be checked by placing an 82-ohm, 5-watt resistor between pins 5 and 16 of either interconnecting plug.

TABLE 6-1

Power Supply	Maximum Voltage Deviation
—100 volt	1 volt
+125 volt	1.25 volts
+300 volt	3 volts
—12.2 volt	0.12 volt

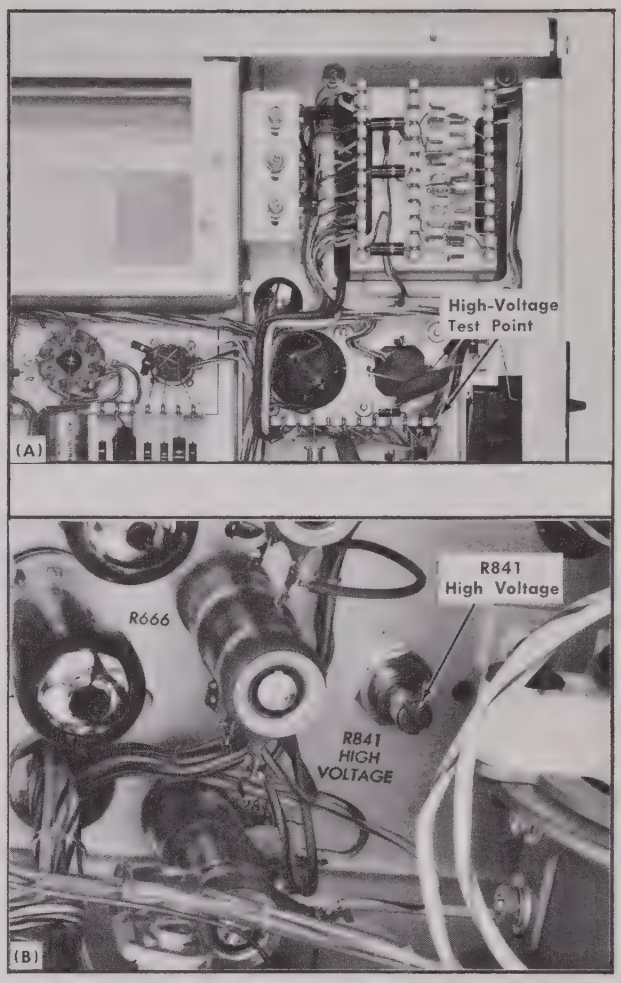


Fig. 6-7. (A) Location of high-voltage test point (bottom view), (B) location of high-voltage adjustment (top view).

7. Check High-Voltage Power-Supply Regulation

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the DC voltmeter from the high-voltage test point (Fig. 6-7A) to chassis ground.

c. Set the autotransformer to 117 (234) volts and note the voltage at the test point.

d. Set the autotransformer to 105 (210) volts and check the voltage. It should be within 100 volts of reading in step c.

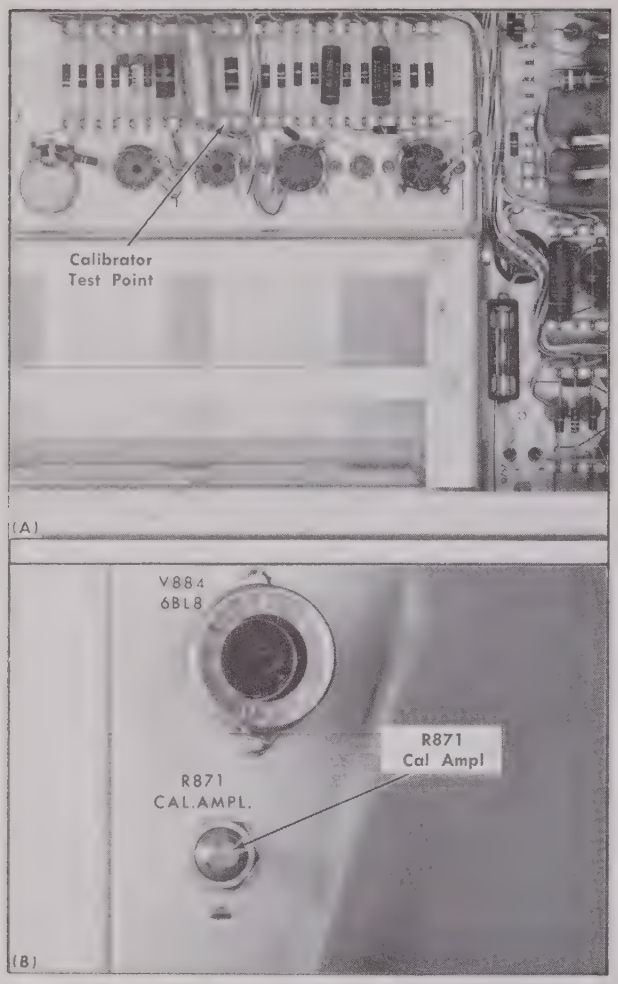


Fig. 6-8. (A) Location of calibrator test point (bottom view), (B) location of calibrator adjustment (top view).

e. Set the autotransformer to 125 (250) volts and check the voltage. Voltage should be within 100 volts of reading in step c.

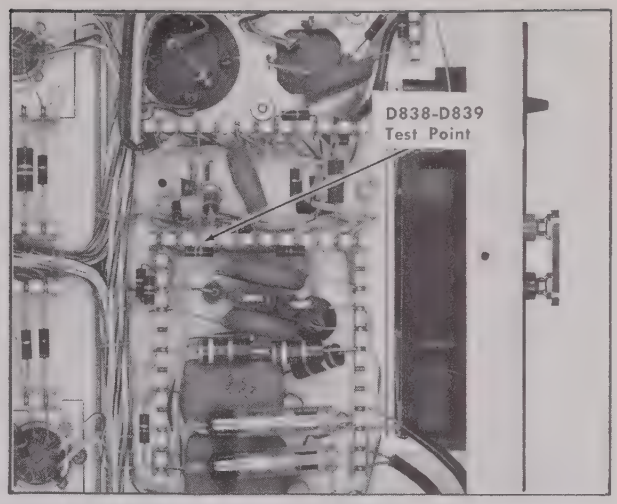


Fig. 6-9. Location of D838-D839 test point (bottom view).

f. Return the autotransformer to 117 (234) volts and disconnect the voltmeter.

8. Adjust Calibrator Amplitude ◐

a. Test equipment setup is shown in Fig. 6-3.

b. Connect the DC voltmeter from the calibrator test point (Fig. 6-8A) to chassis ground.

c. CHECK—Meter reading; +100 volts, ±3 volts. Be sure the CALIBRATOR switch is set to OFF.

d. ADJUST—Cal Ampl adjustment, R871 (Fig. 6-8B), for +100 volts.

9. Check D838-D839 Junction Voltage

a. Connect the voltmeter from the D838-D839 test point (Fig 6-9) to chassis ground.

b. CHECK—Voltage should be less than +0.6 volt DC. Higher voltages could damage a time-base unit with an intensifying circuit.

NOTES

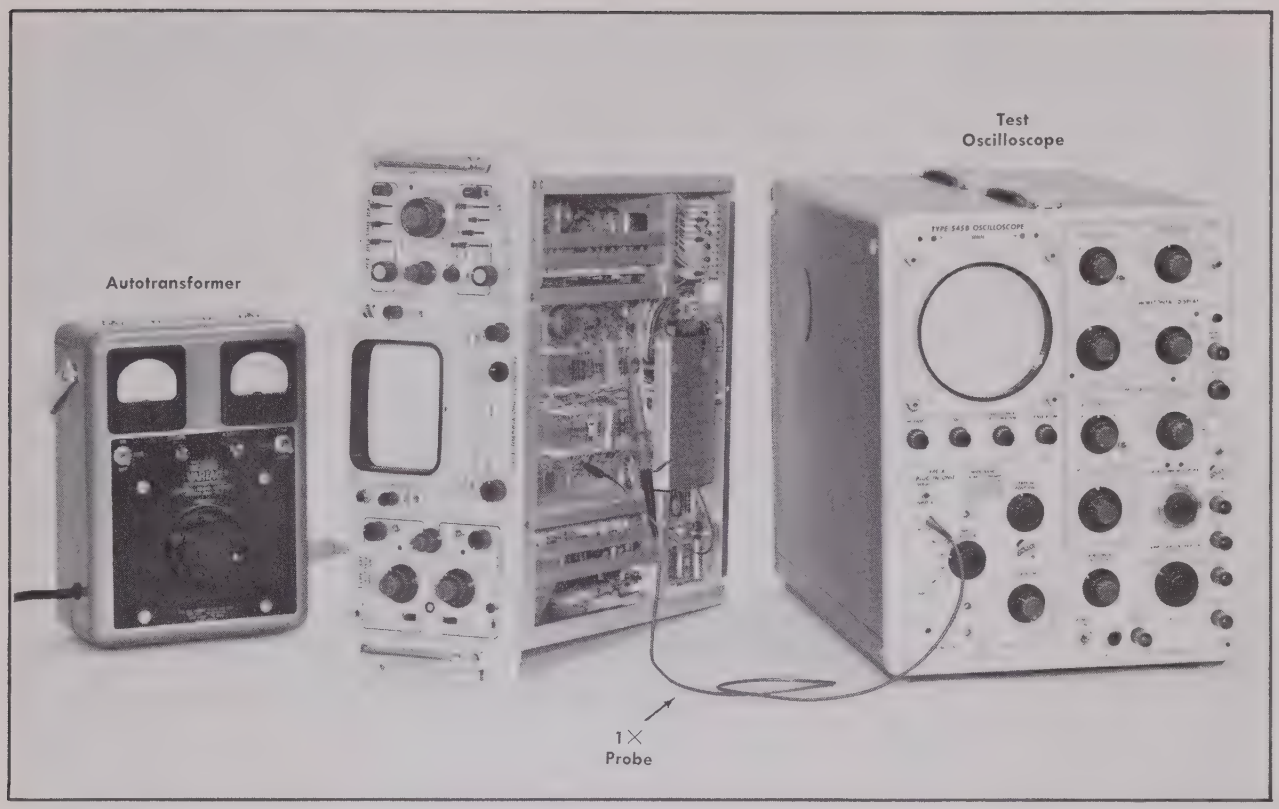


Fig. 6-10. Test equipment setup for power-supply ripple measurements.

Control Settings

Type RM561A

FOCUS	Any position
INTENSITY	Midrange
CALIBRATOR	OFF
SCALE ILLUM	Clockwise
CRT CATHODE SELECTOR	Normal

Amplifier Unit

Position	Midrange
AC DC Gnd	AC
Volts/Division	1
Variable	Calibrated

Time-Base Unit

Position	Midrange
Magnifier	Off
Time/Division	1 millisecond
Variable	Calibrated
Triggering controls	**Adjust so sweep is not triggered**

10. Check Power-Supply Ripple

a. Test equipment setup is shown in Fig. 6-10.

b. Connect the 1× probe to the test oscilloscope input.

c. Set the test oscilloscope volts/division switch to 0.005. Set the input coupling switch to AC.

d. Measure the line-frequency ripple of each regulated power supply at the power-supply test points. Test points are shown in Figs. 6-4A and 6-6. Table 6-2 gives maximum ripple for each supply. Check ripple with autotransformer set at 105 and 125 (210 and 250 if wired for 234-volts nominal). Fig. 6-11 shows typical test oscilloscope display.

e. Disconnect the test oscilloscope and return the autotransformer to line voltage (instrument may be connected directly to line).

TABLE 6-2

Power Supply	Maximum Ripple (millivolts)
—100 volt	5
+125 volt	10
+300 volt	80
—12.2 volt	3
—3300 volt	DO NOT MEASURE

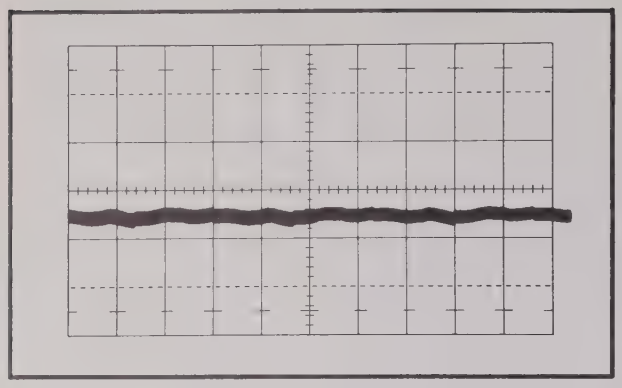


Fig. 6-11. Typical test oscilloscope display showing power-supply ripple (—100-volt supply). Volts/division, 0.005 volts, AC coupled; time/division, 5 milliseconds.

11. Adjust Astigmatism

a. Set the time-base unit triggering controls to produce a trace on the CRT.

b. ADJUST—FOCUS control and ASTIGMATISM adjustment, R864 (Fig. 6-12) for a sharp, well-defined display over the entire trace length.

c. Slight readjustment of these controls may be necessary during normal operation.

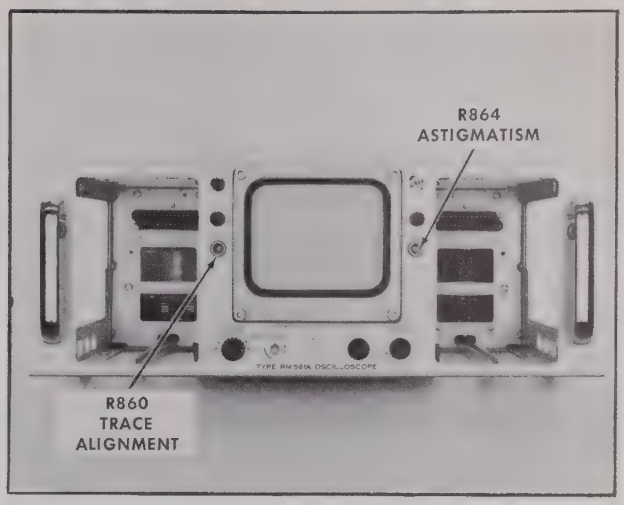


Fig. 6-12. Location of ASTIGMATISM and TRACE ALIGNMENT controls (front panel).

12. Adjust Trace Alignment

a. Adjust the amplifier unit Position control to move the trace to the horizontal graticule centerline.

b. CHECK—The trace should be parallel with the centerline.

c. ADJUST—TRACE ALIGNMENT adjustment, R860 (Fig. 6-12), so the trace is parallel with the horizontal graticule lines.

NOTES

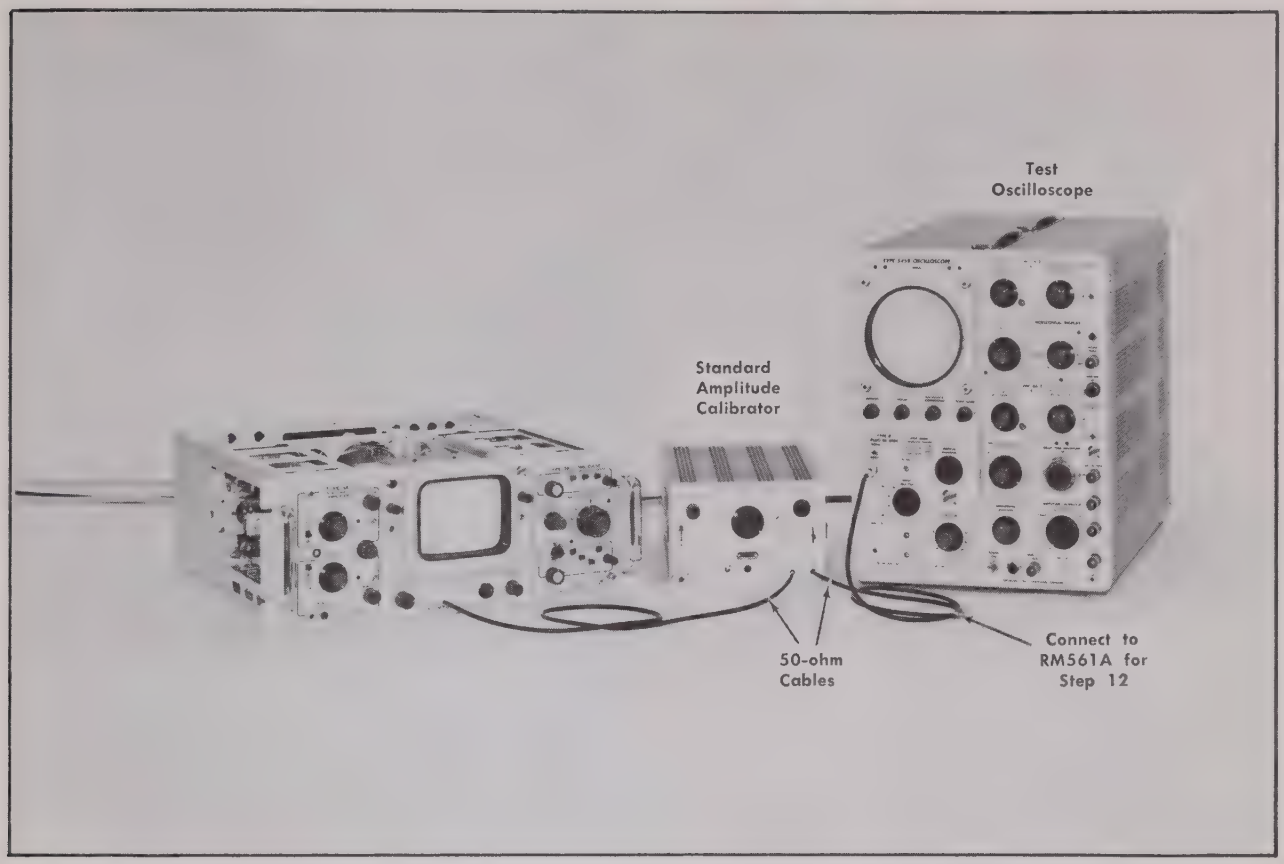


Fig. 6-13. Test equipment setup for geometry adjustment and CALIBRATOR check.

Control Settings

Type RM561A	
FOCUS	Adjust for focused display
INTENSITY	Midrange
CALIBRATOR	**100 V**
SCALE ILLUM	Clockwise
CRT CATHODE SELECTOR	Normal
Amplifier Unit	
Position	Midrange
AC DC Gnd	AC
Volts/Division	1
Variable	Calibrated
Time-Base Unit	
Position	Midrange
Magnifier	Off
Time/Division	1 millisecond
Variable	Calibrated
Triggering Controls	**Automatic**

13. Adjust Cathode-Ray Tube Geometry

a. Test equipment setup is shown in Fig. 6-13.

b. Set the Standard Amplitude Calibrator controls as follows (if the test oscilloscope has a 1-kHz Calibrator, it may be used for this step):

Amplitude	10 Volts
Mode	Square wave
Function	Up
Power	On

c. Connect the Standard Amplitude Calibrator Output connector to the amplifier unit input connector.

d. Adjust the time-base unit Position and Variable Time/Division controls so a rising portion of the waveform coincides with the left and right graticule lines. The INTENSITY control may need to be advanced slightly to view the rising portions of the waveform (top and bottom of square wave should be positioned off of the viewing area).

e. CHECK—Good linearity at the left and right edges of the graticule (Fig. 6-14A shows typical CRT display as well as examples of poor geometry).

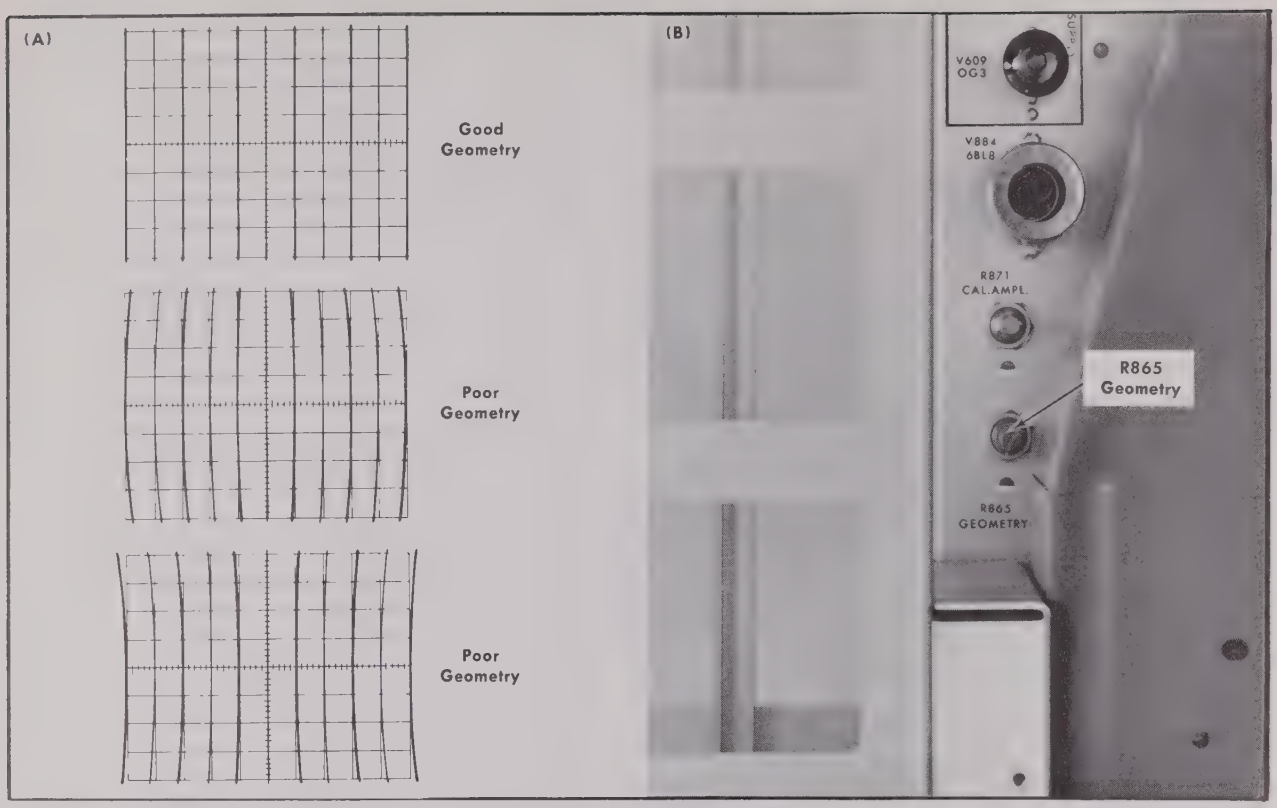


Fig. 6-14. (A) Idealized waveforms showing good geometry with examples of poor geometry, (B) location of Geometry adjustment (top view).

f. ADJUST—Geometry adjustment, R865 (Fig. 6-14B), for best linearity at left and right edges of the graticule. If a setting cannot be found that provides best linearity on both sides of the graticule, a compromise setting will be necessary to provide best overall linearity.

g. Disconnect the signal from the amplifier unit input and return the INTENSITY control to normal setting.

14. Check Calibrator Accuracy

a. Test equipment setup is shown in Fig. 6-13.

b. Change the following Standard Amplitude Calibrator controls:

Amplitude	100 Volts
Mode	+DC
Function	Mixed
AC DC Gnd	DC

c. Connect the CAL OUT connector to the Standard Amplitude Calibrator Unknown Input with a 50-ohm cable.

d. Connect the standard Amplitude Calibrator Output connector to the test oscilloscope input (minimum deflection factor, 0.005 volts/division) with a 50-ohm cable.

e. Connect the six-inch jumper lead from pin 8, V884 (Fig. 6-15A), to chassis ground. This provides a DC calibrator output voltage.

f. The difference between the Standard Amplitude Calibrator +DC voltage and the Type RM561A CALIBRATOR output voltage should be less than 3%. Table 6-3 gives maximum allowable difference for 3% CALIBRATOR accuracy at each position of the CALIBRATOR switch. (The Standard Amplitude Calibrator output can be identified by setting the Type RM561A CALIBRATOR switch to a higher or lower position; the signal which remains is the Standard Amplitude Calibrator output.) Fig. 6-15B shows a typical test oscilloscope display. Check accuracy of all positions between 100 V and 100 mV.

g. Set the CALIBRATOR switch to the .1 V INTO 50 Ω position (1 V position).

h. Connect the 50-ohm termination (067-0515-00) between the CAL OUT connector and the 50-ohm cable using the GR to BNC adapters.

i. Leave the Standard Amplitude Calibrator Amplitude switch set to .1 Volts and set the test oscilloscope volts/division switch to 0.005.

j. The test oscilloscope display should be 0.6 division or less in amplitude for 3% accuracy.

k. Remove the 50-ohm termination and reconnect the 50-ohm cable to the CAL OUT connector.

l. Connect the Standard Amplitude Calibrator Output connector to the ×100 Amplifier Input connector with a 50-ohm cable.

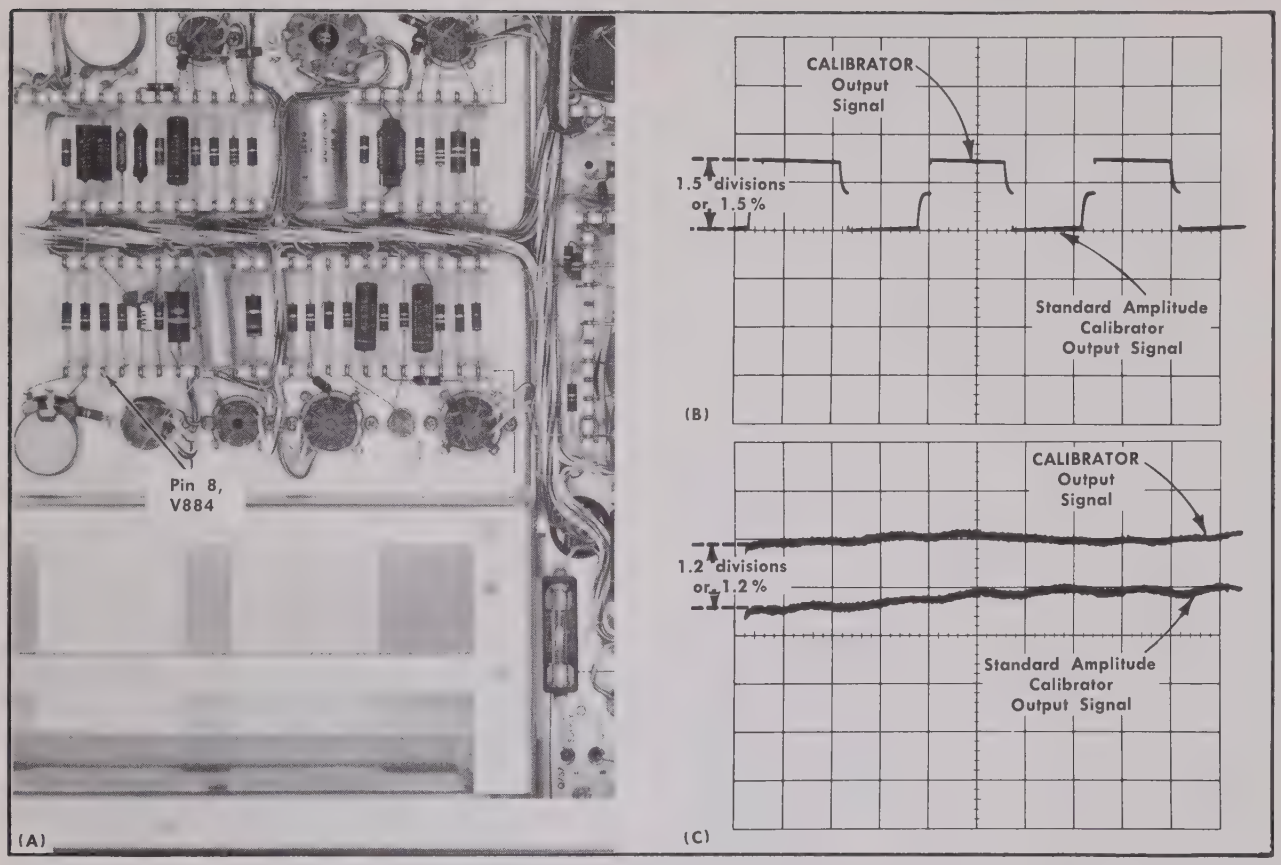


Fig. 6-15. (A) Location of Pin 8, V884 (bottom view), (B) typical test-oscilloscope display showing about +1.5% error in the 10 V position (volts/division, 0.1 volts; time/division, 5 milliseconds), (C) typical test-oscilloscope display showing about +1.2% error in the 10 mV position (volts/division, 20 millivolts; time/division, 0.2 milliseconds; using ×100 Amplifier section).

m. Connect the Output ±50 V Max connector to the input of the test oscilloscope.

n. Set the test oscilloscope time/division switch to 0.2 milliseconds. Adjust the Standard Amplitude Calibrator Output DC Level control to center the trace on the screen.

o. Check the accuracy of the 10 mV and 1 mV CALIBRATOR switch positions. Table 6-3 gives maximum allowable difference and control settings. Fig. 6-15C shows a typical test oscilloscope display.

p. Disconnect all test equipment and remove the jumper lead from pin 8 of V884.

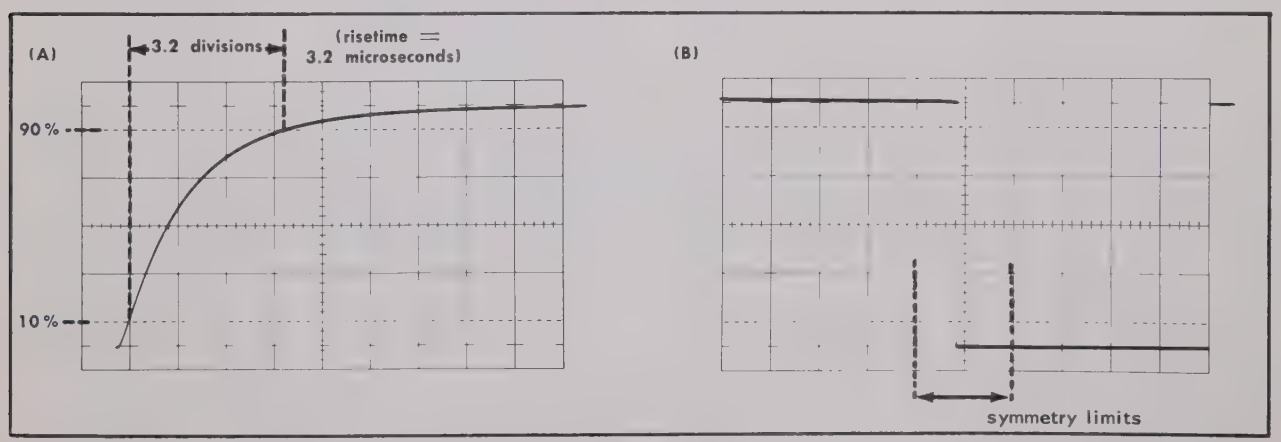


Fig. 6-16. (A) Typical test oscilloscope display for checking Calibrator risetime (time/division, 1 microsceond), (B) typical test oscilloscope display for checking Calibrator symmetry.

TABLE 6-3

Type RM561A CALIBRATOR setting and Standard Amplitude Calibrator setting	Test Oscilloscope Volts/Division Switch Setting	Maximum Display Amplitude for 3% Accuracy (divisions)
100 V	1 Volt	3[5]
10 V	.1 Volt	3
1 V	10 Millivolts	3
100 mV	5 Millivolts	0.6
10 mV	10 Millivolts	3
1 mV	5 Millivolts	0.6

[5]**For maximum Calibrator accuracy, reset the Cal Ampl adjustment for minimum difference.**

15. Check Calibrator Risetime and Symmetry

a. Test equipment setup is shown in Fig. 6-13.

b. Connect the CAL OUT connector to the vertical input of the test oscilloscope with a 50-ohm cable.

c. Set the CALIBRATOR switch to 1 V.

d. Set the test oscilloscope time/division switch to 1 microsecond and the volts/division and variable control for exactly 5 divisions of display (four divisions if using 540A-series test oscilloscope).

e. Check for risetime of less than 6 microseconds as shown by less than 5 divisions between the 10% and 90% points on the test oscilloscope display (see Fig. 6-16A).

f. Set the test oscilloscope Time/Division switch and Variable control to display one complete cycle of the calibrator signal in 10 divisions. Adjust the triggering controls, if necessary, so the display starts on the leading edge of the waveform.

g. Check for Calibrator symmetry of ±20%. This is shown by each segment of the square wave having a length of 4 to 6 divisions (see Fig. 6-16B).

h. Disconnect the test oscilloscope.

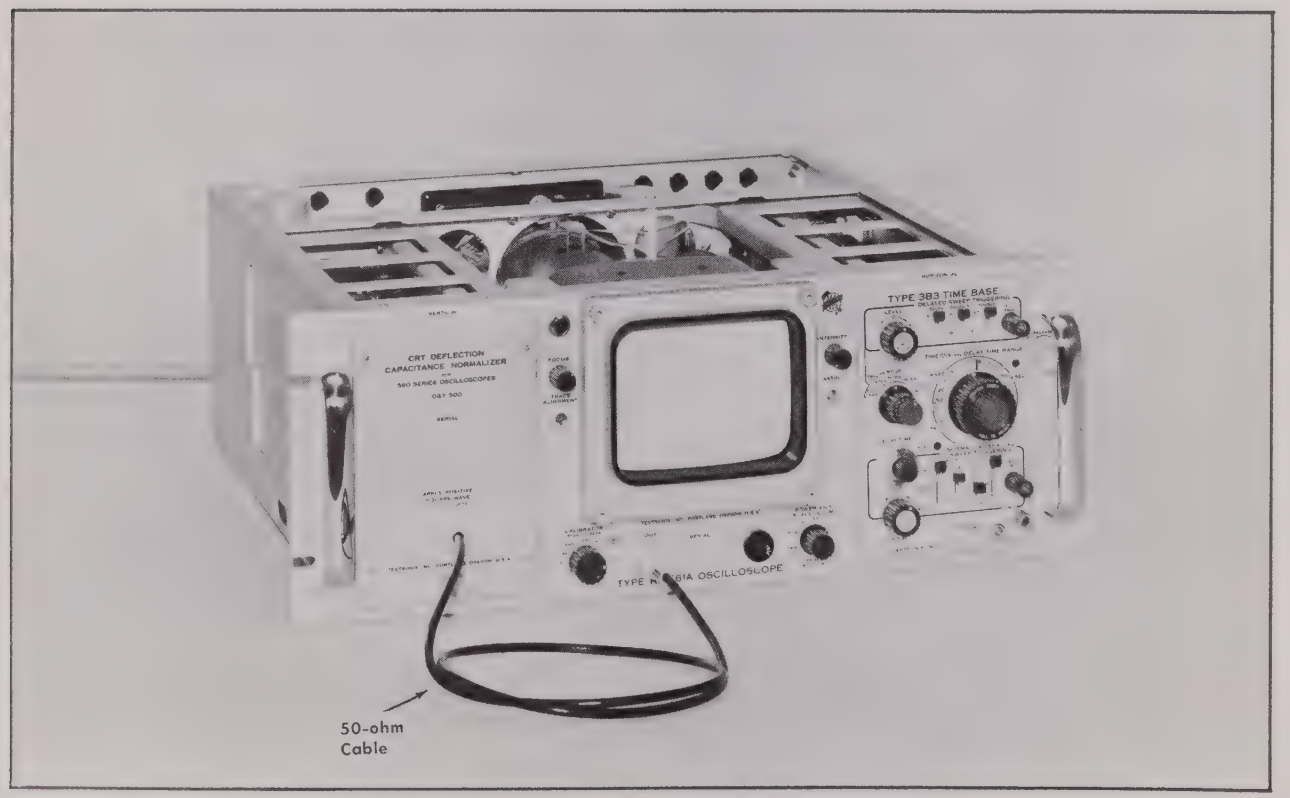


Fig. 6-17. Test equipment setup for vertical and horizontal compensation.

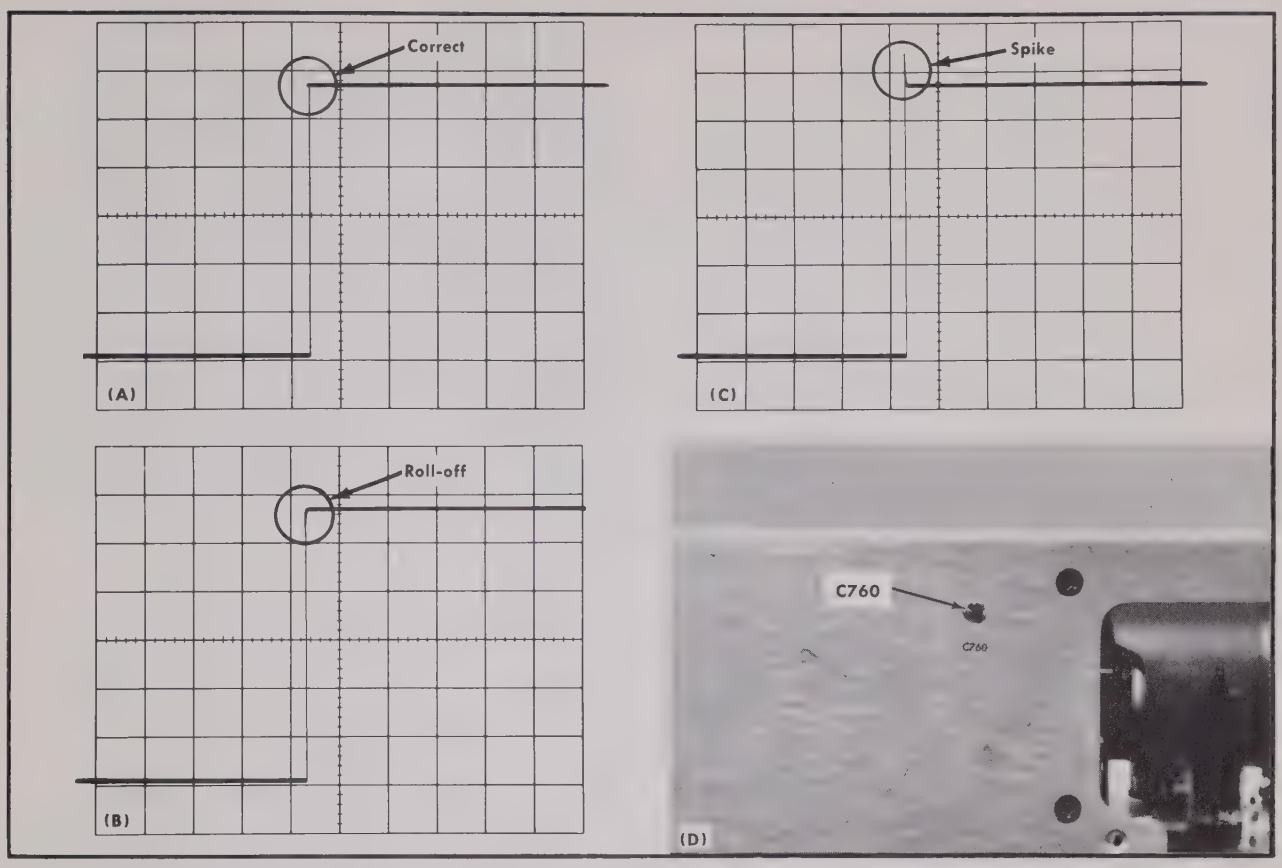


Fig. 6-18. (A) Typical CRT display showing correct vertical compensation adjustment, (B) and (C) incorrect adjustment, (D) location of C760 (left side).

Control Settings

Type RM561A

FOCUS	Adjust for focused display
INTENSITY	Midrange
CALIBRATOR	**100 V**
SCALE ILLUM	Clockwise
CRT CATHODE SELECTOR	Normal

Amplifier unit

Position	Midrange
AC DC Gnd	AC
Volts/Division	1
Variable	Calibrated

Time-Base Unit

Position	Midrange
Magnifier	Off
Time/Division	**.2 millisecond**
Variable	Calibrated
Triggering Controls	**Adjust for triggered sweep**

16A. Adjust Vertical and Horizontal Deflection-Plate Compensation

a. Test equipment is shown in Fig. 6-17.

b. Insert the CRT Deflection Capacitance Normalizer into the left plug-in compartment.

c. Connect the CAL OUT connector to the Capacitance Normalizer input connector.

d. Adjust the time-base triggering controls so the leading edge of the waveform is displayed.

NOTE

The INTENSITY control may need to be advanced slightly to view the leading edge of the waveform.

e. CHECK—For optimum square corner (see Fig. 6-18A).

f. ADJUST—C760 (Fig. 6-18D) for optimum square corner.

g. Interchange the Capacitance Normalizer and the time-base unit. Readjust the FOCUS control and the time-base triggering controls for a stable well-focused display.

h. CHECK—For optimum square corner (see Fig. 6-19A).

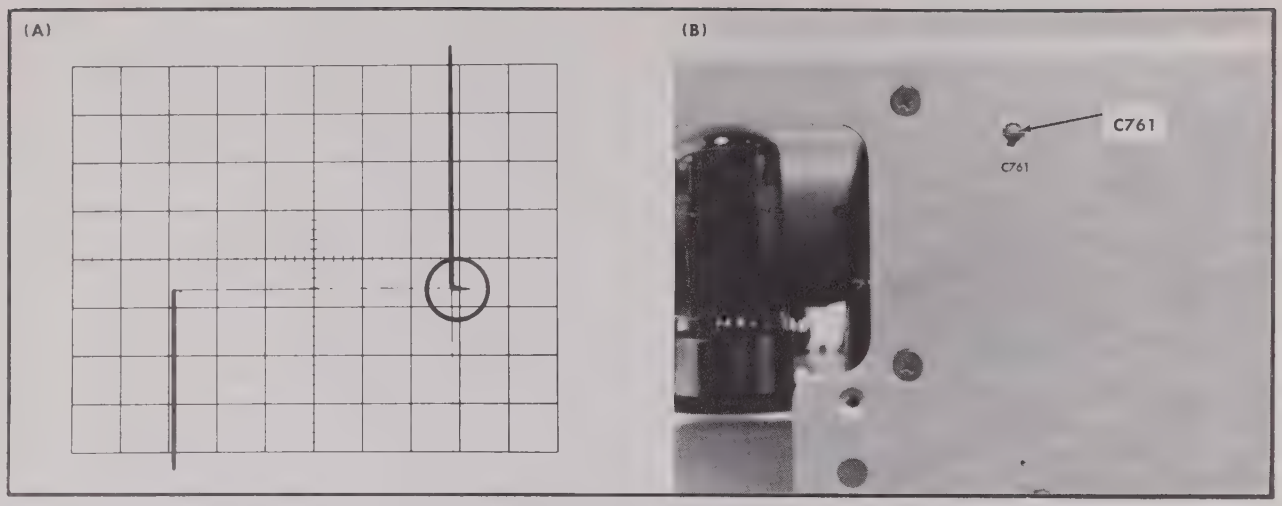


Fig. 6-19. (A) Typical CRT display showing correct adjustment of horizontal compensation, (B) location of C761 (right side).

i. ADJUST—C761 (Fig. 6-19B) for optimum square corner.

j. Remove the Capacitance Normalizer. Replace the amplifier unit in the left compartment and the time-base unit in the right compartment.

16B. Alternative Method of Adjusting Deflection Plate Compensation

NOTE

The following method can be used to adjust the deflection-plate compensation if a Capacitance Normalizer is not available.

The effective deflection-plate capacitance of the CRT is the capacitance seen by the plug-in unit when the deflection plates are driven push-pull. Therefore, it cannot be measured directly with a capacitance meter. However, the individual circuit capacitances which make up the effective deflection-plate capacitance can be measured. These individual circuit capacitances are shown schematically in Fig. 6-20. C1 and C2 represent the capacitance from each deflection plate to ground. C3 represents the capacitance between the deflection plates. The variable capacitor is made up of the circuit capacitance plus the capacitor added for adjustment.

The variable capacitor for the vertical (left) plug-in compartment may be C3 (Fig. 6-20A) or C2 (Fig. 6-20B) depend-

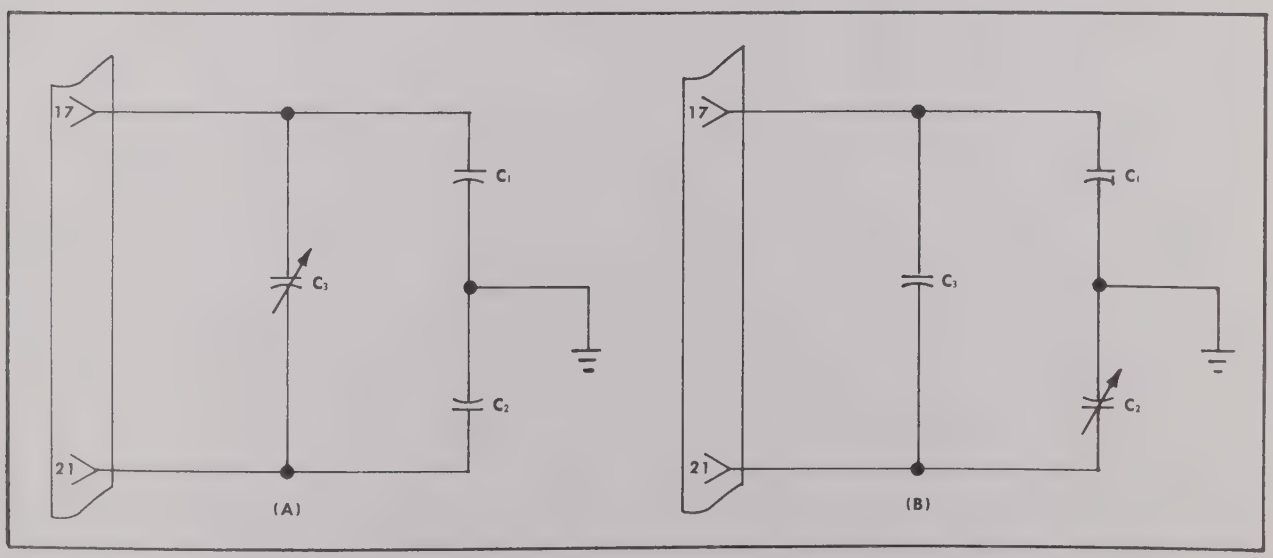


Fig. 6-20. Schematic representation of the effective CRT deflection-plate capacitance; (A) configuration 1, (B) configuration 2.

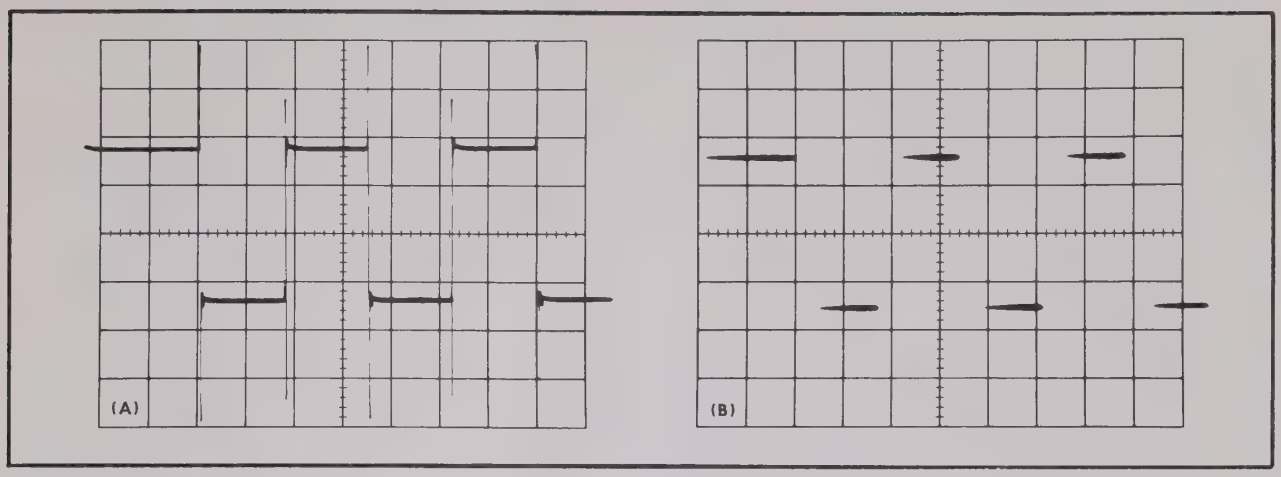


Fig. 6-21. Typical CRT display showing correct chopped blanking. (A) Chopped transients visible with CRT CATHODE SELECTOR switch up (time/division, 2 microseconds), (B) transients blanked out with CRT CATHODE SELECTOR switch in the CHOPPED BLANKING position.

ing on other circuit capacitance values. Check the instrument to determine the configuration and formula to use for correct deflection-plate capacitance.

The effective deflection-plate capacitance, C_{eff}, can be expressed in terms of C1, C2, and C3 as follows:

$$C_{eff} = \frac{C1 + C2}{2} + 2\ (C3)$$

Setting C_{eff} equal to 14.3 picofarads (value set at factory), the value of the variable capacitor can be calculated.

Configuration 1, Fig. 6-20A. $C3 = 7.15\ pF - \frac{C1 + C2}{4}$

Configuration 2, Fig. 6-20B. $C2 = 28.6\ pF - 4\ (C3) - C1$

a. Disconnect the power cord and isolate the Type RM561A from ground.

b. Remove both plug-in units.

c. Connect the capacitance meter guard voltage to pin 21 of the vertical plug-in compartment and measure the capacitance between pin 17 and the oscilloscope chassis—this is C1.

d. Connect the capacitance meter guard voltage to pin 17 and measure the capacitance between pin 21 and the oscilloscope chassis—this is C2. (For configuration 2, connect the guard voltage to the oscilloscope chassis and measure the capacitance between pin 17 and 21—this is C3.)

e. Substitute the measured capacitance values into the equation and solve for C3 (configuration 2, solve for C2).

f. Connect the guard voltage to the oscilloscope chassis and measure the capacitance between pins 17 and 21. (For configuration 2, connect the guard voltage to pin 17 and measure the capacitance between pin 21 and the oscilloscope chassis.)

g. Adjust C760 until the measured capacitance equals the value calculated for C3 in step e (configuration 2, adjust C760 for calculated value of C2).

h. Repeat steps c through g for the horizontal (right) plug-in compartment. Fig. 6-20A shows the individual capacitances for the horizontal plug-in compartment.

17. Check Dual-Trace Chopped Blanking

a. Set the amplifier unit Mode switch to Chopped (this check can be made only with a dual-trace plug-in unit).

b. Set the amplifier unit AC DC Gnd switches to Gnd.

c. Position the traces about three divisions apart.

d. Set the time-base Time/Division switch to display several cycles of the waveform and adjust the triggering controls for a stable display.

e. With the CRT CATHODE SELECTOR switch in the normal position, notice the overshoot on the display (see Fig 6-21A).

f. Set the CRT CATHODE SELECTOR switch to CHOPPED BLANKING. The between-channel switching transients should be removed from the display (see Fig. 6-21B).

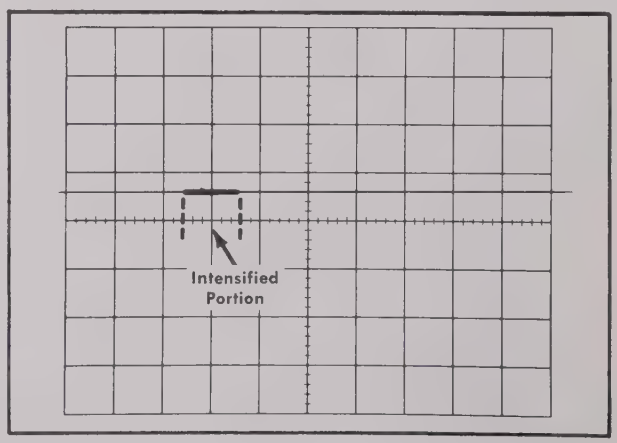


Fig. 6-22. Typical CRT display showing correct intensifier circuit operation.

18. Check CRT Intensifier Circuit

a. Set the time-base Time/Division switch to 1 millisecond and the delayed sweep Time/Division switch to 0.1 millisecond (this check can be made only with a delayed sweep plug-in unit).

b. Set the amplifier unit mode switch to display only one channel.

c. Adjust the time-base triggering controls to produce a trace.

d. Adjust the FOCUS control and the time-base triggering controls for a well-focused free-running (or automatic triggered) trace.

e. Turn the time-base Mode switch to Intensified (not triggered).

f. An intensified portion should appear on the trace (see Fig. 6-22). If the display appears only as a shortened trace, increase the INTENSITY setting slightly until the complete trace, showing an intensified portion, appears.

g. Turn the delay time control throughout its range and check that the intensified portion moves along the trace.

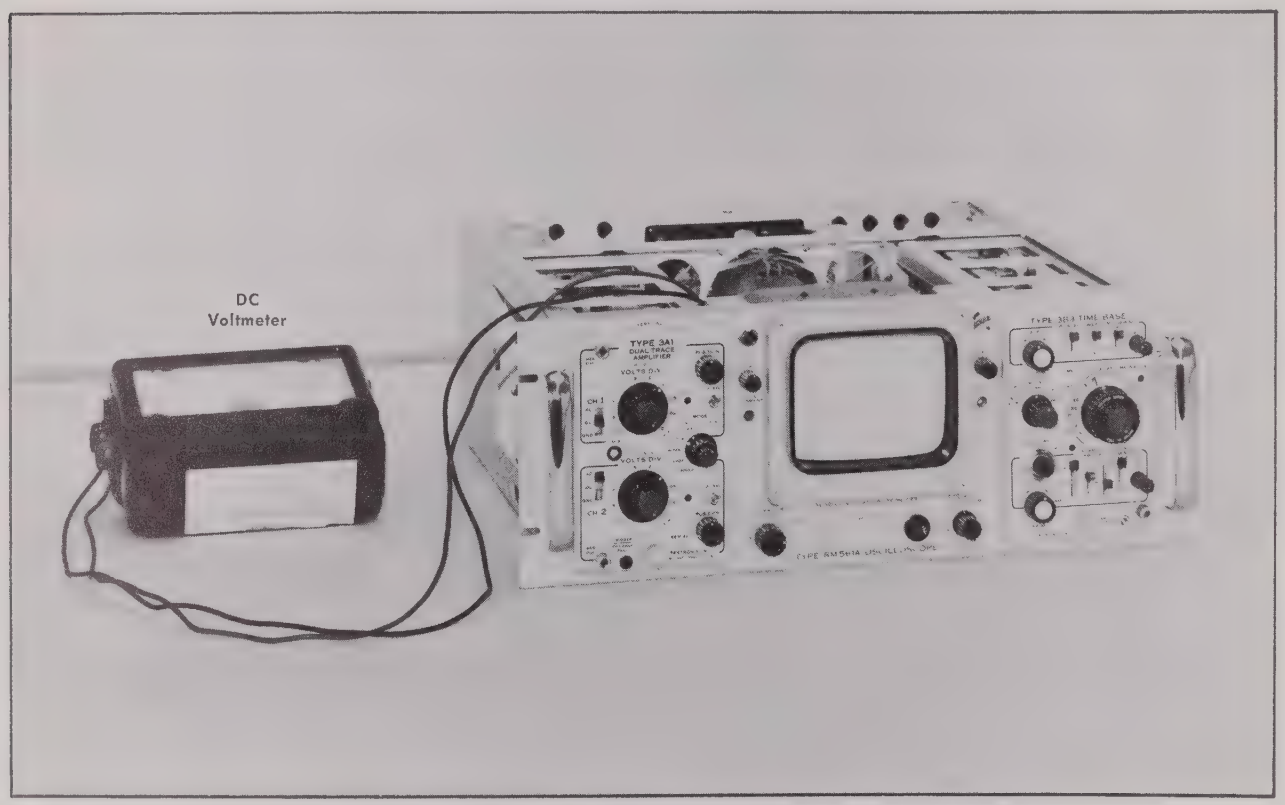


Fig. 6-23. Test equipment setup for checking CRT vertical and horizontal sensitivity.

Control Settings

Type RM561A

FOCUS	Adjust for focused display
INTENSITY	**Midrange**
CALIBRATOR	**10 V**
SCALE ILLUM	Clockwise
CRT CATHODE SELECTOR	**Normal**

Amplifier Unit

Position	Midrange
AC DC Gnd	AC
Volts/Division	1
Variable	Calibrated

Time-Base Unit

Position	Midrange
Magnifier	Off
Time/Division	**10 milliseconds**
Variable	Calibrated
Triggering controls	**Automatic**

CAUTION

In steps 19 and 20 be careful not to short the CRT deflection pins to chassis ground.

19. Check CRT Vertical Sensitivity

a. Test equipment setup is shown in Fig. 6-23.

b. Connect the DC voltmeter between the vertical deflection-plate pins. Be careful not to bend the pins.

c. Turn the amplifier unit Position control to move the trace to the top graticule line.

d. Note the meter reading.

e. Turn the amplifier unit Position control to move the trace to the bottom graticule line.

f. Again note the meter reading.

g. Calculate the difference in voltage between step d and f. Divide by 8 to determine the deflection voltage/division (sensitivity).

h. Sensitivity should be 19.5 volts/division, ±1 volt.

20. Check CRT Horizontal Sensitivity

a. Test equipment setup is shown in Fig. 6-23.

b. Interchange the plug-ins so the time-base unit is in the left compartment and the amplifier unit is in the right compartment.

c. Connect the DC voltmeter between the vertical deflection-plate pins. Be careful not to bend the pins.

d. Adjust the FOCUS control and the time-base triggering controls for a well-focused free-running (or automatic triggered trace).

e. Turn the amplifier unit Position control to move the trace to the left graticule line.

f. Note the meter reading.

g. Turn the amplifier unit Position control to move the trace to the right graticule line.

h. Again note the meter reading.

i. Calculate the difference in voltage between step f and h. Divide by 10 to determine the deflection voltage/division (sensitivity).

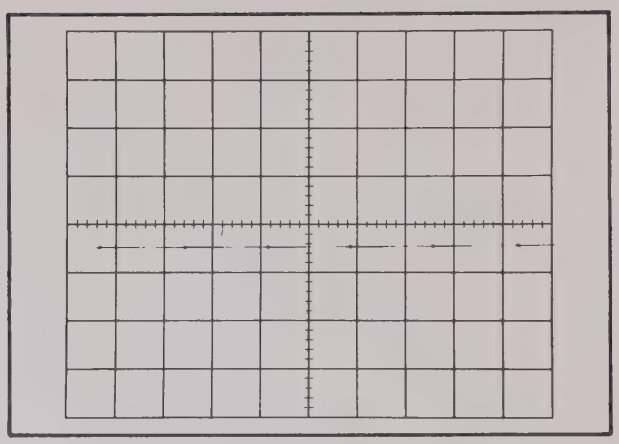


Fig. 6-24. Typical CRT display showing correct intensity modulation (time/division, 10 milliseconds).

j. Sensitivity should be 18.4 volts/division, ±0.9 volt.

k. Disconnect the voltmeter and return the amplifier unit to the left compartment and the time-base unit to the right compartment.

21. Check Intensity (Z-Axis) Modulation

a. Remove the ground strap between the rear-panel binding posts.

b. Connect the CALIBRATOR signal to the EXT CRT CATHODE binding post with the BNC-to-BNC and BNC-to-banana jack jumper leads.

c. Check the display for intensified dots (see Fig. 6-24). It may be necessary to reduce the INTENSITY setting slightly to see the dots.

d. Remove the jumper leads and replace the ground strap.

This completes the calibration of the Type RM561A. Disconnect all test equipment. Replace the top and bottom panels. The gain of the amplifier unit and timing of the time-base unit should be checked before using the system.

NOTES

ABBREVIATIONS AND SYMBOLS

A or amp	amperes
AC or ac	alternating current
AF	audio frequency
α	alpha—common-base current amplification factor
AM	amplitude modulation
$\approx$	approximately equal to
β	beta—common-emitter current amplification factor
BHB	binding head brass
BHS	binding head steel
BNC	baby series "N" connector
$\times$	by or times
C	carbon
C	capacitance
cap.	capacitor
cer	ceramic
cm	centimeter
comp	composition
conn	connector
$\sim$	cycle
c/s or cps	cycles per second
CRT	cathode-ray tube
csk	countersunk
dB	decibel
dBm	decibel referred to one milliwatt
DC or dc	direct current
DE	double end
°	degrees
°C	degrees Celsius (degrees centigrade)
°F	degrees Fahrenheit
°K	degrees Kelvin
dia	diameter
$\div$	divide by
div	division
EHF	extremely high frequency
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ε	epsilon—2.71828 or % of error
$\geq$	equal to or greater than
$\leq$	equal to or less than
ext	external
F or f	farad
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
FM	frequency modulation
ft	feet or foot
G	giga or 10^9
g	acceleration due to gravity
Ge	germanium
GMV	guaranteed minimum value
GR	General Radio
$>$	greater than
H or h	henry
h	height or high
hex.	hexagonal
HF	high frequency
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
HV	high voltage
Hz	hertz (cycles per second)
ID	inside diameter
IF	intermediate frequency
in.	inch or inches
incd	incandescent
∞	infinity
int	internal
$\int$	integral
k	kilohms or kilo (10^3)
k Ω	kilohm
kc	kilocycle
λ	lambda—wavelength
$<$	less than
LF	low frequency
lg	length or long
LV	low voltage
M	mega or 10^6
m	milli or 10^{-3}
MΩ or meg	megohm
μ	micro or 10^{-6}
mc	megacycle
met.	metal
mm	millimeter
ms	millisecond
—	minus
mtg hdw	mounting hardware
n	nano or 10^{-9}
no. or #	number
ns	nanosecond
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
Ω	omega—ohms
ω	omega—angular frequency
p	pico or 10^{-12}
/	per
%	percent
PHB	pan head brass
ϕ	phi—phase angle
π	pi—3.1416
PHS	pan head steel
+	plus
$\pm$	plus or minus
PIV	peak inverse voltage
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
pwr	power
RC	resistance capacitance
RF	radio frequency
RFI	radio frequency interference
RHB	round head brass
ρ	rho—resistivity
RHS	round head steel
r/min or rpm	revolutions per minute
RMS	root mean square
s or sec.	second
SE	single end
Si	silicon
SN or S/N	serial number
T	tera or 10^{12}
TC	temperature compensated
TD	tunnel diode
THB	truss head brass
θ	theta—angular phase displacement
thk	thick
THS	truss head steel
tub.	tubular
UHF	ultra high frequency
V	volt
VAC	volts, alternating current
var	variable
VDC	volts, direct current
VHF	very high frequency
VSWR	voltage standing wave ratio
W	watt
w	wide or width
w/	with
w/o	without
WW	wire-wound
xmfr	transformer

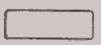
PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial or model number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

SPECIAL NOTES AND SYMBOLS

X000	Part first added at this serial number
00X	Part removed after this serial number
*000-0000-00	Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, Inc., or reworked or checked components.
Use 000-0000-00	Part number indicated is direct replacement.
	Screwdriver adjustment.
	Control, adjustment or connector.
	Heat sink.

SECTION 7

ELECTRICAL PARTS LIST

Values are fixed unless marked Variable.

Ckt. No.	Tektronix Part No.	Description	S/N Range
		Bulbs	
B601	150-001	Incandescent, G.E. #47, Graticule Light	
B602	150-001	Incandescent, G.E. #47, Graticule Light	
B603	150-004	Incandescent, G.E. #328, Pilot Light	
B856	150-025	Neon, NE-2E	
B857	150-025	Neon, NE-2E	
		Capacitors	

Tolerance ±20% unless otherwise indicated.
Tolerance of all electrolytic capacitors are as follows (with exceptions):

3 V — 50 V = −10%, +250%
51 V — 350 V = −10%, +100%
351 V — 450 V = −10%, +50%

C611	285-510	.01 μf	MT		400 v
C616	285-510	.01 μf	MT		400 v
C640A,B	Use 290-224	340 μf x 10 μf	EMC		250 v
C644	Use 290-224	340 μf x 10 μf	EMC		250 v
C642A,B	Use 290-224	340 μf x 10 μf	EMC		250 v
C650	285-510	.01 μf	MT		400 v
C667	290-002	8 μf	EMT		450 v
C670	285-510	.01 μf	MT		400 v
C720A	Use 290-086	2000 μf	EMC		30 v
C720B	Use 290-086	2000 μf	EMC		30 v
C732	Use 290-201	100 μf	EMT		15 v
C737	283-026	.2 μf	Disc Type		25 v
C757	Use 290-231	100 μf	EMT		25 v
C760	281-027	.7-3 pf	Tub.	Var.	
C761	281-027	.7-3 pf	Tub.	Var.	
C801	283-006	.02 μf	Disc Type		600 v
C803	283-000	.001 μf	Disc Type		500 v
C807	285-502	.001 μf	MT		1000 v
C822	283-071	.0068 μf	Disc Type		5000 v
C830	Use 283-0071-00	.0068 μf	Disc Type		5000 v
C832	Use 283-0071-00	.0068 μf	Disc Type		5000 v
C837	Use 283-0034-00	.005 μf	Disc Type		4000 v
C841	285-519	.047 μf	MT		400 v
C842	283-071	.0068 μf	Disc Type		5000 v
C853	Use 283-0034-00	.005 μf	Disc Type		4000 v
C876	290-025	6.25 μf	EMT		300 v
C878	281-523	100 pf	Cer.		350 v
C884	281-524	150 pf	Cer.		500 v

Diodes

Ckt. No.	Tektronix Part No.	Description	S/N Range
D640A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D642A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D644A,B,C,D	*152-047	Silicon Replaceable by 1N2862	
D720	152-035	Silicon 1N1563A	
D721	152-035	Silicon 1N1563A	
D745	*152-0107-00	Silicon Replaceable by 1N647	X8270-up
D838	*152-047	Silicon Replaceable by 1N2862	
D839	*152-047	Silicon Replaceable by 1N2862	

Fuses

F601	159-005	3 Amp	3AG	Slo-Blo	117 v oper.	50 & 60 cycle
F601	159-041	1.25 AMP	3AG	Slo-Blo	234 v oper.	50 & 60 cycle
F720	159-023	2 Amp	3AG	Slo-Blo		

Inductors

L860	Use *108-285	Beam Rotator

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R601†	311-340	50 Ω		Var.		SCALE ILLUM.
R602	308-142	30 Ω	3 w		WW	5%
R603	304-330	33 Ω	1 w			
R609	302-106	10 meg	½ w			
R610	302-104	100 k	½ w			
R611	302-102	1 k	½ w			
R612	302-272	2.7 k	½ w			
R616	311-015	10 k		Var.	WW	—100 VOLTS
R617	308-186	80 k	½ w		WW	1%
R618	308-226	10 k	½ w		WW	1%
R619	302-224	220 k	½ w			
R624	302-473	47 k	½ w			
R625	302-222	2.2 k	½ w			
R626	302-184	180 k	½ w			
R627	302-102	1 k	½ w			
R628	308-176	4 k	20 w		WW	5%
R632	302-102	1 k	½ w			
R633	302-473	47 k	½ w			
R635	301-302	3 k	½ w			5%
R640	304-100	10 Ω	1 w			

† Concentric with SW601. Furnished as a unit.

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Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R642	304-100	10 Ω	1 w				
R644	304-100	10 Ω	1 w				
R650	309-101	330 k	½ w		Prec.	1%	
R651	309-162	250 k	½ w		Prec.	1%	
R652	302-102	1 k	½ w				
R653	302-225	2.2 meg	½ w				
R654	302-474	470 k	½ w				
R655	302-685	6.8 meg	½ w				
R656	311-068	500 k	.2 w	Var.		+125 VOLTS	
R657	302-684	680 k	½ w				
R658	302-273	27 k	½ w				
R659	302-333	33 k	½ w				
R663	302-102	1 k	½ w				
R664	302-102	1 k	½ w				
R666	308-176	4 k	20 w		WW	5%	
R667	308-176	4 k	20 w		WW	5%	
R670	309-156	1.024 meg	½ w		Prec.	1%	
R671	309-053	333 k	½ w		Prec.	1%	
R672	302-102	1 k	½ w				
R673	302-105	1 meg	½ w				
R675	302-825	8.2 meg	½ w				
R676	311-068	500 k	.2 w	Var.		+300 VOLTS	
R677	304-224	220 k	1 w				
R678	302-394	390 k	½ w				
R679	302-333	33 k	½ w				
R729	302-823	82 k	½ w				X5160-up
R730	311-068	500 k	.2 w	Var.		−12.2 VOLTS	
R731	309-104	2.05 k	½ w		Prec.	1%	
R732	310-115	15 k	1 w		Prec.	1%	
R733	302-564	560 k	½ w				5001-5159
R733	301-394	390 k	½ w			5%	5160-up
R734	302-334	330 k	½ w				
R735	302-272	2.7 k	½ w				
R737	302-151	150 Ω	½ w				
R744	308-231	220 Ω	3 w		WW	5%	
R749	303-0563-00	56 k	1 w			5%	X8270-up
R754	302-471	470 Ω	½ w				
R759	302-104	100 k	½ w				
R770	302-564	560 k	½ w				
R781	316-470	47 Ω	¼ w				
R782	316-470	47 Ω	¼ w				
R783	316-470	47 Ω	¼ w				
R784	316-470	47 Ω	¼ w				
R801	306-681	680 Ω	2 w				
R802	302-562	5.6 k	½ w				
R803	306-273	27 k	2 w				
R806	302-104	100 k	½ w				
R807	302-472	4.7 k	½ w				

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Resistors *(Cont'd)*

Ckt. No.	Tektronix Part No.		Description				S/N Range
R813	302-101	100 Ω	½ w				
R815	302-474	470 k	½ w				
R816	302-102	1 k	½ w				
R831	302-104	100 k	½ w				
R832	302-106	10 meg	½ w				
R833	311-349	2 meg		Var.		INTENSITY	
R834	302-105	1 meg	½ w				
R835	Use *050-115	Replacement Kit					5001-5609
R835†	(3) 306-565	5.6 meg	2 w				5610-up
	(2) 306-685	6.8 meg	2 w				
R836	302-223	22 k	½ w				
R837	302-471	470 Ω	½ w				
R838	301-242	2.4 k	½ w			5%	
R839	302-104	100 k	½ w				
R840	301-125	1.2 meg	½ w			5%	
R841	311-042	2 meg		Var.		HIGH VOLTAGE	
R842	Use *050-147	Replacement Kit					5001-5609
R842††	(3) 306-395	3.9 meg	2 w				5610-up
R844	311-254	5 meg	.2 w	Var.		FOCUS	
R846	304-225	2.2 meg	1 w				
R849	302-223	22 k	½ w				
R851	302-104	100 k	½ w				
R852	302-273	27 k	½ w				
R853	302-471	470 Ω	½ w				
R854	302-105	1 meg	½ w				
R860	311-007	2 x 1 k		Var.		ALIGNMENT	
R861	302-680	68 Ω	½ w				
R862	302-823	82 k	½ w				
R863	302-823	82 k	½ w				
R864	311-206	250 k		Var.		ASTIGMATISM	
R865	311-026	100 k		Var.		GEOMETRY	
R870	301-393	39 k	½ w			5%	
R871	311-315	20 k		Var.		CAL. AMPL.	
R872	301-154	150 k	½ w			5%	
R873	302-103	10 k	½ w				
R876	301-153	15 k	½ w			5%	
R877	301-183	18 k	½ w			5%	
R878	301-564	560 k	½ w			5%	
R879	Use 301-114	110 k	½ w			5%	
R883	305-223	22 k	2 w			5%	
R885	310-066	18 k	1 w		Prec.	1%	
R886	309-030	1.8 k	½ w		Prec.	1%	
R887	309-072	180 Ω	½ w		Prec.	1%	
R888	309-064	20 Ω	½ w		Prec.	1%	
R890	309-030	1.8 k	½ w		Prec.	1%	
R891	309-072	180 Ω	½ w		Prec.	1%	
R892	309-064	20 Ω	½ w		Prec.	1%	
R898	309-178	250 Ω	½ w		Prec.	1%	
R899	*308-090	¼ Ω	1 w		WW	1%	

† S/N 5610-up *050-115 may be used
†† S/N 5610-up *050-147 may be used

©

Switches

Ckt. No.	Tektronix Part No. Unwired	Wired	Description		S/N Range
SW601†	311-340			POWER ON-OFF	
SW854	260-447		Slide	CRT CATHODE SELECTOR	
SW870	260-394	*262-515	Rotary	CALIBRATOR	

† Concentric with R601. Furnished as a unit.

Thermal Cutout

TK601	260-246	Thermal Cutout 123°

Transformers

T601	*120-280	L.V. Power
T801	*120-297	H.V. Power

Transistors

Q624	*151-087	Selected from 2N1131
Q734	151-040	2N1302
Q744	151-042	2N1378
Q757	Use 151-0165-00	2N3614

Electron Tubes

V609	154-291	0G3	
V627	154-307	7233	
V634	154-187	6DJ8	
V654	154-022	6AU6	
V667	154-056	6080	
V674	154-022	6AU6	
V800	154-167	6CZ5	
V814	154-046	12BH7	
V822	154-051	5642	
V832	154-051	5642	
V859††	Use *154-449	T5032-31-1 CRT Standard Phosphor	5001-6885
V859	*154-449	T5032-31-1 CRT Standard Phosphor	6886-up
V884	154-278	6BL8	

††S/N 5001-6885 add *050-214 kit.

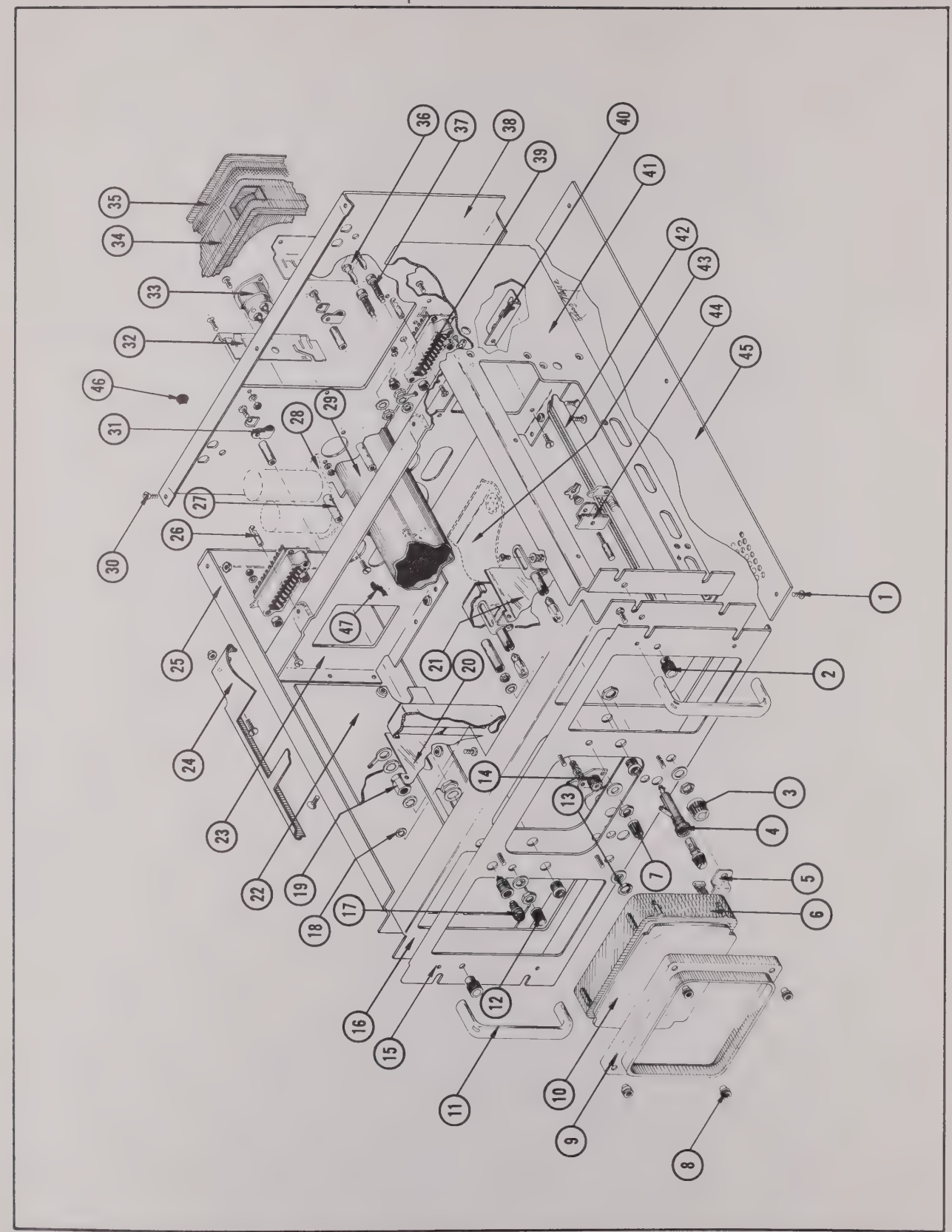
©

SECTION 8

MECHANICAL PARTS LIST

A list of abbreviations and special symbols in use throughout this manual will be found immediately preceding the Electrical Parts List, Section 7. Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Parts ordering information is also located immediately preceding Section 7.

Exploded View



EXPLODED VIEW

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	211-0565-00			20	SCREW, 6-32 x 1/4 in. truss HS, phillips slot
2	366-0109-00			2	KNOB, PLUG-IN SECURING
3	366-0113-00	5001	6209	1	KNOB, POWER AND SCALE ILLUM.
	366-0220-00	6210		1	KNOB, POWER AND SCALE ILLUM.
	- - - - - -			-	knob includes:
	213-0004-00	5001	6209	1	SCREW, set, 6-32 x 3/16 inch HSS
	213-0020-00	6210		1	SCREW, set, 6-32 x 1/8 inch HSS
	210-0413-00	5001	6209	1	NUT, hex, brass, 3/8-32 x 1/2 in.
	210-0590-00	6210		1	NUT, hex, brass, 3/8-32 x 7/16 in.
4	352-0014-00			1	HOLDER, fuse, with hardware
	200-0237-00	5001	6279X	1	COVER, insulation, fuse holder, clear
5	352-0049-00	5001	6885	1	HOLDER, reflector shield
	214-0442-00	6886		1	SPRING, light pipe
	337-0540-00	5001	6885	1	SHIELD, reflector
	387-0934-00	6886		1	PLATE, light reflector
6	354-0181-00	5001	6885	1	RING, CRT shockmount, black neoprene
	124-0167-00	6886		1	STRIP, neoprene
7	366-0153-00			1	KNOB, INTENSITY
	210-0583-00			1	NUT, hex, brass, 1/4-32 x 5/16 in.
	210-0940-00			1	WASHER, steel, 1/4 in.
8	210-0571-00			4	NUT, graticule cover, 3/8 in. alum. 10-32 knurled
9	200-0426-00			1	COVER, trim and graticule assembly
10	337-0539-00	5001	6885X	1	SHIELD, implosion, plexiglass
	337-0586-01	X8580		1	SHIELD, crt light
11	367-0032-00			2	HANDLE, nickel plated
	213-0090-00			2	SCREW, 10-32 x 1/2 in. hex
12	366-0153-00			1	KNOB, FOCUS
	210-0583-00			1	NUT, hex, brass, 1/4-32 x 5/16 in.
	210-0940-00			1	WASHER, steel, 1/4 in.
13	366-0113-00			1	KNOB, CALIBRATOR
	210-0413-00			1	NUT, hex, brass, 3/8-32 x 1/2 in.
	210-0840-00			1	WASHER, steel
	210-0013-00			1	LOCKWASHER, steel, internal 3/8 x 11/16 in.
14	131-0064-00	5001	5279	1	CONNECTOR, chassis mount. cal. out coax
	131-0279-00	5280		1	CONNECTOR, BNC
	- - - - - -			-	Mounting Hardware: (not included)
	406-0244-00			1	BRACKET, nylon molded, coax insulator
	210-0224-00			1	LUG, solder, #10, non-locking
	210-0812-00			2	WASHER, fiber #10
	210-0004-00			2	LOCKWASHER, steel, internal #4
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 in.
	210-0961-00	X5280		1	WASHER, plastic
15	333-0731-00			1	PANEL, front
16	387-0696-00			1	PLATE, subpanel, front
17	136-0031-00			1	SOCKET, light, red, assembly
18	210-0011-00			2	LOCKWASHER, steel, internal 1/4 in.

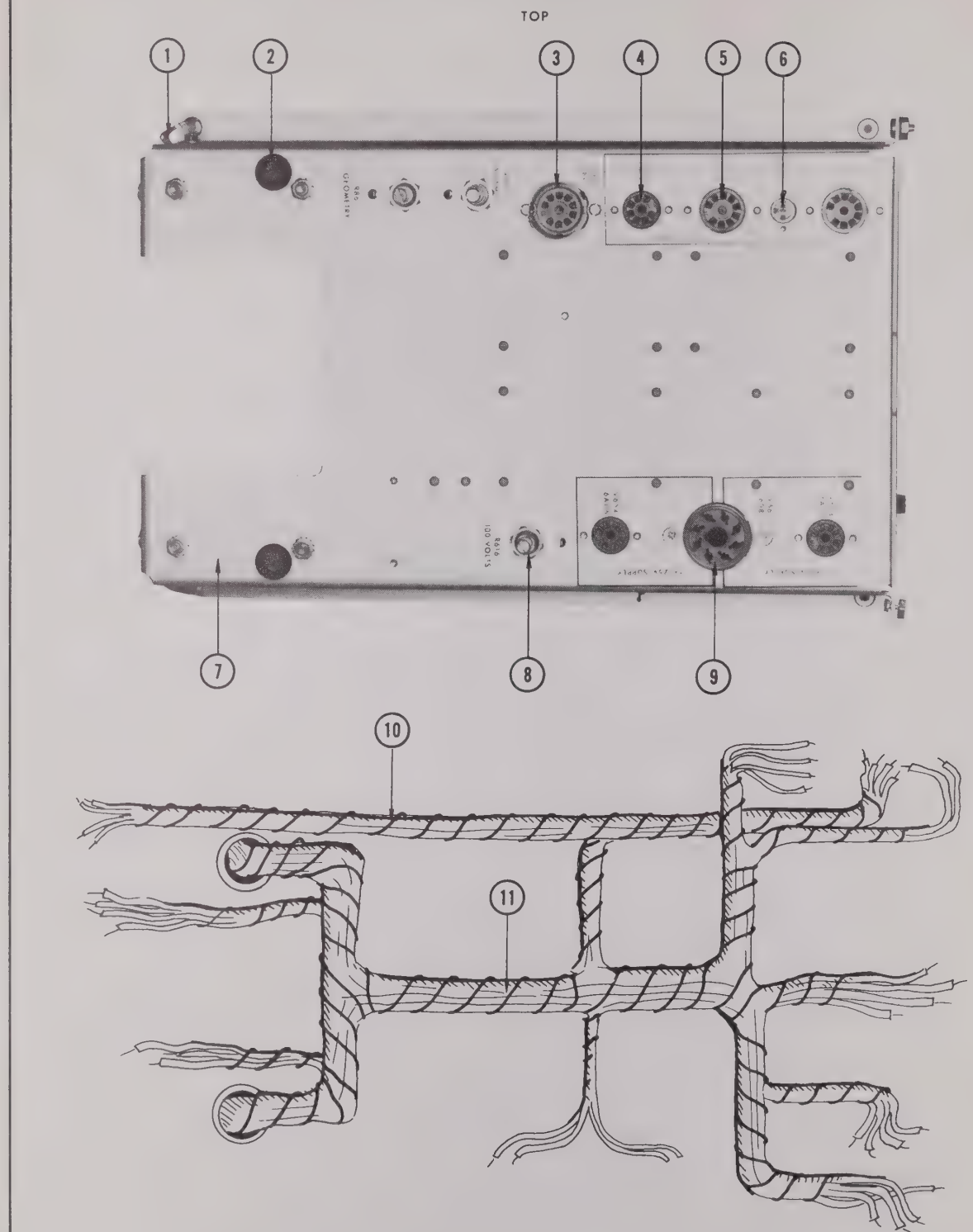
EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
19	358-0010-00			2	BUSHING, alum. $^{3}/_{8}$-32 x $^{9}/_{16}$ in.
	210-0013-00			2	LOCKWASHER, steel, internal $^{3}/_{8}$ x $^{11}/_{16}$ in.
	210-0494-00			2	NUT, hex, alum. $^{3}/_{8}$-32 x $^{1}/_{2}$ x $^{11}/_{16}$ in.
	210-0012-00			2	LOCKWASHER, steel, pot, internal $^{3}/_{8}$ x $^{1}/_{2}$ in.
	210-0207-00			2	LUG, solder, pot, plain, $^{3}/_{8}$ in.
20	337-0536-00			1	SHIELD, Focus and Intensity, left
21	337-0535-00			1	SHIELD, Focus and Intensity, right
22	387-0450-00			1	PLATE, left side cover
	387-0449-00			1	PLATE, right side cover
	- - - - - -			-	Mounting Hardware: (not included)
	211-0504-00			8	SCREW, 6-32 x $^{1}/_{4}$ in. BHS
	211-0541-00			8	SCREW, 6-32 x $^{1}/_{4}$ in. FHS, 100° CSK, phillips
23	387-0716-00			1	PLATE, bulkhead
	- - - - - -			-	Mounting Hardware: (not included)
	212-0002-00			10	SCREW, 8-32 x $^{1}/_{4}$ in. FHS, 100° CSK
	210-0458-00			10	NUT, keps, steel, 8-32 x $^{11}/_{32}$ in.
24	406-0716-00			2	BRACKET, plug-in, alum.
	- - - - - -			-	Mounting Hardware: (not included)
	212-0004-00			2	SCREW, 8-32 x $^{5}/_{16}$ in. BHS
	212-0070-00			2	SCREW, 8-32 x $^{5}/_{16}$ in. FHS, phillips
	210-0458-00			4	NUT, keps, steel, 8-32 x $^{11}/_{32}$ in.
25	387-0447-00			1	PLATE, side left
26	352-0015-00			2	HOLDER, nylon, for coil form
	213-0045-00			2	SCREW, 4-40 x $^{5}/_{16}$ in. Pan Head, phillips
27	385-0113-00			2	ROD, nylon, $^{5}/_{16}$ x 1 $^{1}/_{8}$ in.
	211-0507-00			2	SCREW, 6-32 x $^{5}/_{16}$ in BHS
28	Pg. 6-8				Chassis, rear
29	Pg. 6-12				CRT Shield
30	212-0070-00			32	SCREW, 8-32 x $^{5}/_{16}$ in. FHS, phillips
	210-0458-00			32	NUT, keps, steel, 8-32 x $^{11}/_{32}$ in.
31	385-0013-00			2	ROD, nylon, $^{5}/_{16}$ x $^{3}/_{4}$ in.
	343-0004-00			2	CLAMP, cable, $^{5}/_{16}$ in., plastic
	210-0863-00			2	WASHER, steel, "D" Type for #10 screw
	211-0507-00			4	SCREW, 6-32 x $^{5}/_{16}$ in. BHS
32	351-0046-00			2	GUIDE, fan clips
					Mounting Hardware: (not included)
	211-0538-00			2	SCREW, 6-32 x $^{5}/_{16}$ in. FHS, 100° CSK, phillips
	210-0006-00			2	LOCKWASHER, steel, internal #6
	210-0407-00			2	NUT, hex, 6-32 x $^{1}/_{4}$ in.
33	131-0150-00			1	CONNECTOR, chassis mount, 3 wire motor base assembly
	213-0041-00			2	SCREW, 5-32 x $^{3}/_{16}$ in. Pan H, phillips
34	119-0013-00	5001	5132	1	BLOWER, fan, assembly
	119-0026-00	5133		1	BLOWER, fan, assembly
35	378-0761-00			1	SCREEN, grille for fan
36	134-0012-00			1	PLUG, plated, banana male, twin
37	136-0139-00			1	SOCKET, banana jack assembly, with red nylon cap
	136-0140-00			1	SOCKET, banana jack assembly, with charcoal nylon cap
	210-0898-00			1	WASHER, insulating, red
	210-0011-00			1	LOCKWASHER, steel, internal $^{1}/_{4}$ in.
	210-0223-00			1	LUG, solder, $^{1}/_{4}$ in.
	210-0465-00			3	NUT, hex, brass, $^{1}/_{4}$-32 x $^{3}/_{8}$ in.

EXPLODED VIEW *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
38	387-0695-00	5001	6441	1	PLATE, rear
	387-0937-00	6442		1	PLATE, rear
					Mounting Hardware: (not included)
	212-0004-00			4	SCREW, 8-32 x 5/16 in. BHS
	210-0458-00			4	NUT, keps, steel, 8-32 x 11/32 in.
39	131-0148-00			2	CONNECTOR, chassis mount, 24 contact
					Mounting Hardware: (not included)
	211-0014-00			2	SCREW, 4-40 x 1/2 in. BHS
	166-0029-00			2	TUBE, spacer, alum.
	210-0004-00			2	LOCKWASHER, steel, internal #4
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 in.
40	406-0893-00			1	BRACKET, pot mounting
					Mounting Hardware: (not included)
	211-0504-00			2	SCREW, 6-32 x 1/4 in. BHS
41	387-0446-00			1	PLATE, side right
42	351-0047-00			2	GUIDE, rail track, alum.
					Mounting Hardware: (not included)
	211-0541-00			2	SCREW, 6-32 x 1/4 in. FHS, 100° CKS, phillips
	210-0407-00			1	NUT, hex, brass, 6-32 x 1/4 in.
43	Pg. 6-6				Chassis, front
44	214-0052-00	5001	6319	1	FASTENER, right, with stop assembly
	214-0424-00	6320		1	FASTENER, right, with stop assembly
	214-0053-00	5001	6319	1	FASTENER, left, with stop assembly
	214-0425-00	6320		1	FASTENER, left, with stop assembly
					Mounting Hardware: (not included)
	210-0004-00			2	LOCKWASHER, steel, internal #4
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 in.
45	387-0452-00			2	PLATE, dust cover, top and bottom
					Mounting hardware: (not included)
	211-0565-00			10	SCREW, 6-32 x 1/4 in. truss HS, phillips slot
46	134-0067-00	X6442		8	PLUG, grey nylon
47	344-0111-00	X7730		1	CLIP, deflection lead

Front Chassis & Cable Harness

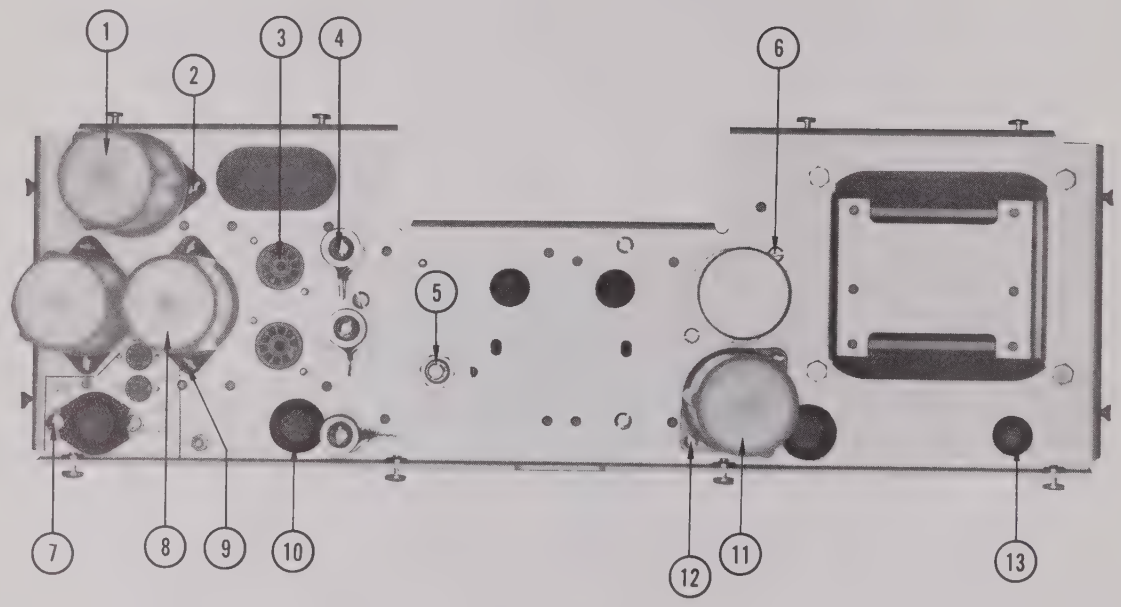


FRONT CHASSIS & CABLE HARNESS

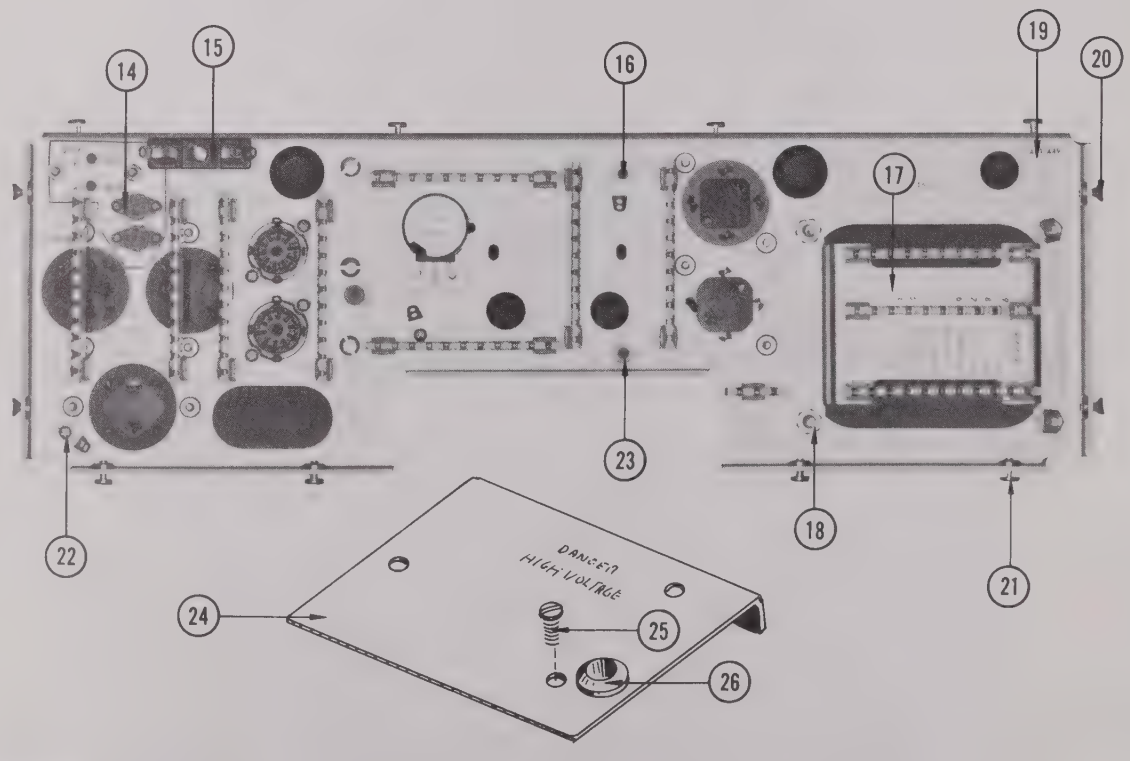
REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	344-0095-00			2	CLIP, grounding
					Mounting Hardware: (not included)
	211-0559-00			1	SCREW, steel, 6-32 x 3/8 in. FHS, 100° CSK
	210-0803-00			1	WASHER, steel, 6L x 3/8 in.
	210-0006-00			1	LOCKWASHER, steel, internal #6
	210-0407-00			1	NUT, hex, brass, 6-32 x 1/4 in.
2	348-0006-00			2	GROMMET, rubber, 3/4 in.
3	136-0022-00			2	SOCKET, STM9S
					Mounting Hardware: (not included)
	211-0033-00			2	SCREW, 4-40 x 5/16 in. Pan HS, with lockwasher
	210-0004-00			2	LOCKWASHER, steel internal #4
	210-0406-00			2	NUT, hex, brass, 4-40 x 3/16 in.
4	136-0008-00			3	SOCKET, STM7G
					Mounting Hardware: (not included)
	213-0044-00			2	SCREW, 5-32 x 3/16 in. Pan H, thread cutting
5	136-0015-00			2	SOCKET, STM9G
					Mounting Hardware: (not included)
	213-0044-00			2	SCREW, 5-32 x 3/16 in. Pan H, thread cutting
6	136-0095-00	5001	6639	1	SOCKET, 4 pin, transistor
	136-0181-00	6640		1	SOCKET, 3 pin transistor
					Mounting Hardware: (not included)
	213-0113-00	5001	6639	2	SCREW, 2-32 x 5/16 in. RHS, thread forming
	354-0234-00	6640		1	RING, locking, transistor socket
7	441-0448-00			1	CHASSIS, front
					Mounting Hardware: (not included)
	212-0004-00			6	SCREW, 8-32 x 5/16 in. BHS
	212-0070-00			2	SCREW, 8-32 x 5/16 in. FHS, phillips
	210-0458-00			4	NUT, keps, steel, 8-32 x 11/32 in.
8					Pot Mounting Hardware:
	210-0413-00			1	NUT, hex, brass, 3/8-32 x 1/2 in.
	210-0840-00			1	WASHER, steel
9	136-0013-00			1	SOCKET, STM8
					Mounting Hardware: (not included)
	211-0538-00			2	SCREW, 6-32 x 5/16 in. FHS, 100° CSK, phillips
	210-0006-00			1	LOCKWASHER, steel, internal #6
	210-0203-00			1	LUG, solder, SE6, long
	210-0407-00			2	NUT, hex, brass, 6-32 x 1/4 in.
10	179-0699-00	5001	5969	1	CABLE harness
	179-0857-00	5970		1	CABLE harness
11	179-0683-00			1	CABLE harness, chassis

Rear Chassis

TOP



BOTTOM



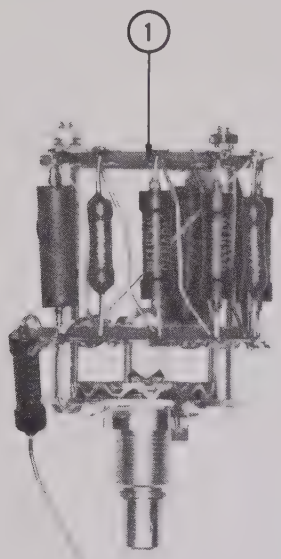
REAR CHASSIS

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	200-0258-00	5001	7799	1	COVER, capacitor, $3^{1}/_{32}$ inches
	200-0259-00	7800		1	COVER, capacitor, $3^{9}/_{16}$ inches
	386-0254-00			1	PLATE, fiber, large, capacitor mounting
	432-0044-00	X7800		1	BASE, capacitor mounting
	- - - - - -			-	Mounting Hardware: (not included)
2	211-0543-00	5001	7799	2	SCREW, 6-32 x $^{5}/_{16}$ in. RHS
	211-0532-00	7800		2	SCREW, 6-32 x $^{3}/_{4}$ inch Fil HS
3	136-0015-00			2	SOCKET, STM9G
	- - - - - -			-	Mounting Hardware: (not included)
	213-0044-00			2	SCREW, thread cutting, 5-32 x $^{3}/_{16}$ in. Pan H phillips
4	- - - - - -			-	Resistor Mounting Hardware:
	212-0037-00			3	SCREW, 8-32 x $1^{3}/_{4}$ in. Fil HS
	210-0808-00			3	WASHER, brass, centering resistor
	210-0462-00			3	NUT, hex, alum. 8-32 x $^{1}/_{2}$ in.
	212-0004-00			3	SCREW, 8-32 x $^{5}/_{16}$ in. BHS
5	- - - - - -			-	Pot Mounting Hardware:
	210-0413-00			1	NUT, hex, brass, $^{3}/_{8}$-32 x $^{1}/_{2}$ in.
	210-0840-00			1	WASHER, steel
6	386-0255-00			1	PLATE, metal large, capacitor mounting
	- - - - - -			-	Mounting Hardware: (not included)
	211-0534-00			2	SCREW, 6-32 x $^{5}/_{16}$ in. PHS, with lockwasher
7	- - - - - -			-	Transistor Mounting Hardware:
	211-0510-00			2	SCREW, 6-32 x $^{3}/_{8}$ in. BHS
	210-0006-00			1	LOCKWASHER, steel, internal #6
	210-0407-00			2	NUT, hex, brass, 6-32 x $^{1}/_{4}$ in.
8	200-0293-00			2	COVER, capacitor, polyethylene
	386-0254-00			2	PLATE, fiber, large, capacitor mounting
9	211-0543-00			4	SCREW, (capacitor assembly) 6-32 x $^{5}/_{16}$ in. RHS
10	348-0050-00			2	GROMMET, delrin, $^{3}/_{4}$ in.
11	200-0259-00			1	COVER, capacitor, polyethylene
	432-0044-00			1	BASE, capacitor mounting
	386-0254-00			1	PLATE, fiber, large, capacitor mounting
	- - - - - -			-	Mounting Hardware: (not included)
12	211-0532-00			2	SCREW, 6-32 x $^{3}/_{4}$ in. HS Fil
13	348-0005-00			5	GROMMET, rubber, $^{1}/_{2}$ in.
14	136-0095-00	5001	6639	2	SOCKET, 4 pin, transistor
	136-0181-00	6640		2	SOCKET, 3 pin transistor
	- - - - - -			-	Mounting Hardware: (not included)
	213-0113-00	5001	6639	2	SCREW, 2-32 x $^{5}/_{16}$ in. RHS, phillips, thread forming
	354-0234-00	6640		1	RING, locking, transistor socket
15	352-0031-00			1	HOLDER, fuse, single, 3AG
	- - - - - -			-	Mounting Hardware: (not included
	211-0510-00			1	SCREW, 6-32 x $^{3}/_{8}$ in. BHS
	210-0006-00			1	LOCKWASHER, steel, internal #6
	210-0407-00			1	NUT, hex, brass, 6-32 x $^{1}/_{4}$ in.

REAR CHASSIS *(Cont'd)*

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
16	166-0099-00			2	TUBE, spacer, alum. $1/4 \times 1\ 23/32$ in.
	- - - - - -			-	Mounting Hardware: (not included)
	211-0507-00			1	SCREW, 6-32 x 5/16 in. BHS
	210-0202-00			1	LUG, solder, SE6
17	406-0617-00	5001	6209	1	BRACKET, transformer strip mounting
	406-0937-00	6210		1	BRACKET, transformer mounting
	- - - - - -			-	Mounting Hardware: (not included)
18	210-0564-00			4	NUT, 10-32 x 3/8 in.
	210-0010-00			4	LOCKWASHER, steel, internal #10
19	441-0449-00	5001	6209	1	CHASSIS, rear
	441-0540-00	6210		1	CHASSIS, rear
	- - - - - -			-	Mounting Hardware: (not included)
20	212-0070-00			4	SCREW, 8-32 x 5/16 in. FHS
21	212-0004-00			8	SCREW, 8-32 x 5/16 in. BHS
22	210-0201-00			2	LUG, solder, SE4
	213-0044-00			2	SCREW, thread cutting, 5-32 x 3/16 in. Pan H
23	385-0060-00			2	ROD, nylon, 5/16 dia. x 1 3/4 in.
	211-0507-00			2	SCREW, 6-32 x 5/16 in. BHS
24	337-0534-00			1	SHIELD, H.V. Power
	- - - - - -			-	mounting hardware: (not included)
25	211-0507-00			3	SCREW, 6-32 x 5/16 in. BHS
26	348-0005-00	5001	9059	1	GROMMET, rubber, 1/2 in.
	348-0063-00	9060		1	GROMMET, plastic, 1/2 inch

SWITCHES

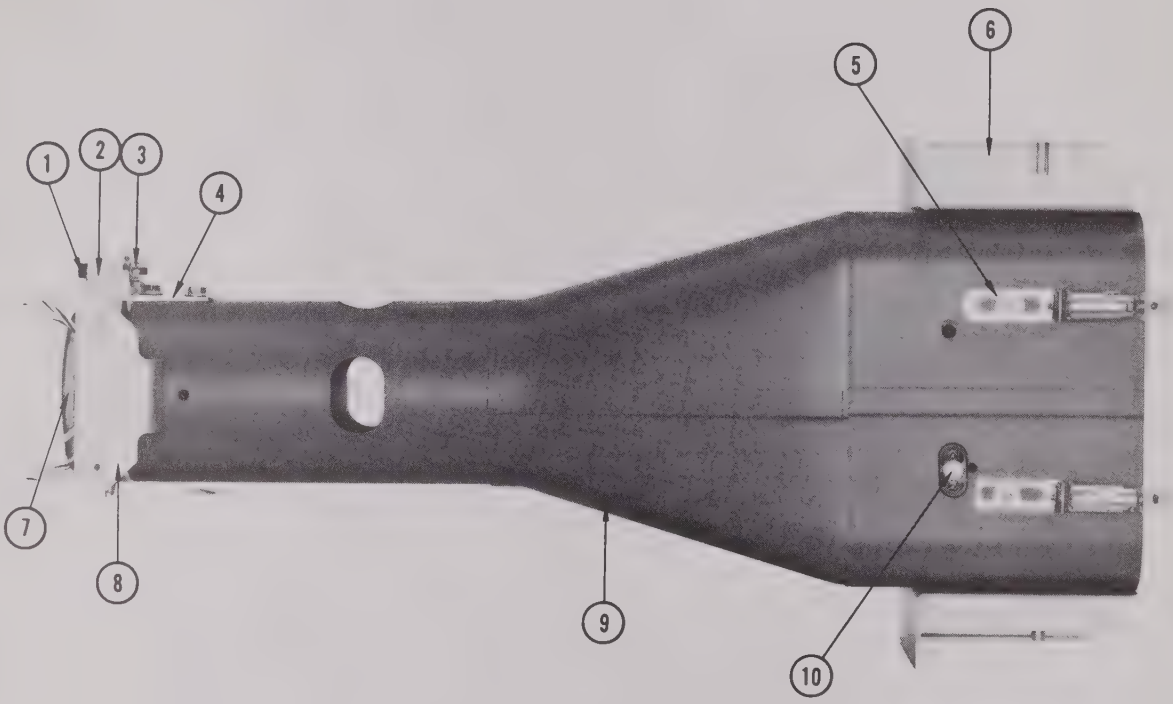


CALIBRATOR

SLIDE SPDT

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	262-0515-00			1	SWITCH, Calibrator, wired
	260-0394-00			1	SWITCH, Calibrator, unwired
					Mounting Hardware: (not included)
	210-0413-00			1	NUT, hex, brass $^{3}/_{8}$-32 x $^{1}/_{2}$ in.
	210-0840-00			1	WASHER, steel
	210-0013-00			1	LOCKWASHER, steel, internal $^{3}/_{8}$ x $^{11}/_{16}$ in.
2	260-0449-00			1	SWITCH, raw, slide, SPDT
					Mounting Hardware: (not included)
	211-0008-00			2	SCREW, 4-40 x $^{1}/_{4}$ in. BHS
	210-0406-00			2	NUT, hex, brass, 4-40 x $^{3}/_{16}$ in.

CRT SHIELD



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	211-0576-00			2	SCREW, 6-32 x 7/8 in. socket head cap, black finish
	210-0949-00			2	WASHER, brass, 1/2 in.
2	354-0147-00	5001	5489	1	RING, clamping, delrin, 1/2 x 2 1/4 in.
	354-0212-00	5490		1	RING, clamping, delrin
	- - - - - -			-	ring includes:
	124-0160-00	X5490		1	STRIP, liner
	211-0560-00			1	SCREW, 6-32 x 1 in. RHS
	210-0419-00			1	NUT, hex, brass, 6-32 x 1/4 in.
3	214-0207-00			1	NUT, adj. securing
4	406-0730-00			1	BRACKET, parallax adj. zinc plated
	- - - - - -			-	Mounting Hardware: (not included)
	211-0534-00			4	SCREW, 6-32 x 5/16 in. PHS, withlockwasher
	210-0803-00			4	WASHER, steel, 6L x 3/8 in.
	210-0006-00			4	LOCKWASHER, steel, internal #6
	210-0407-00			4	NUT, hex, brass, 6-32 x 1/4 in.

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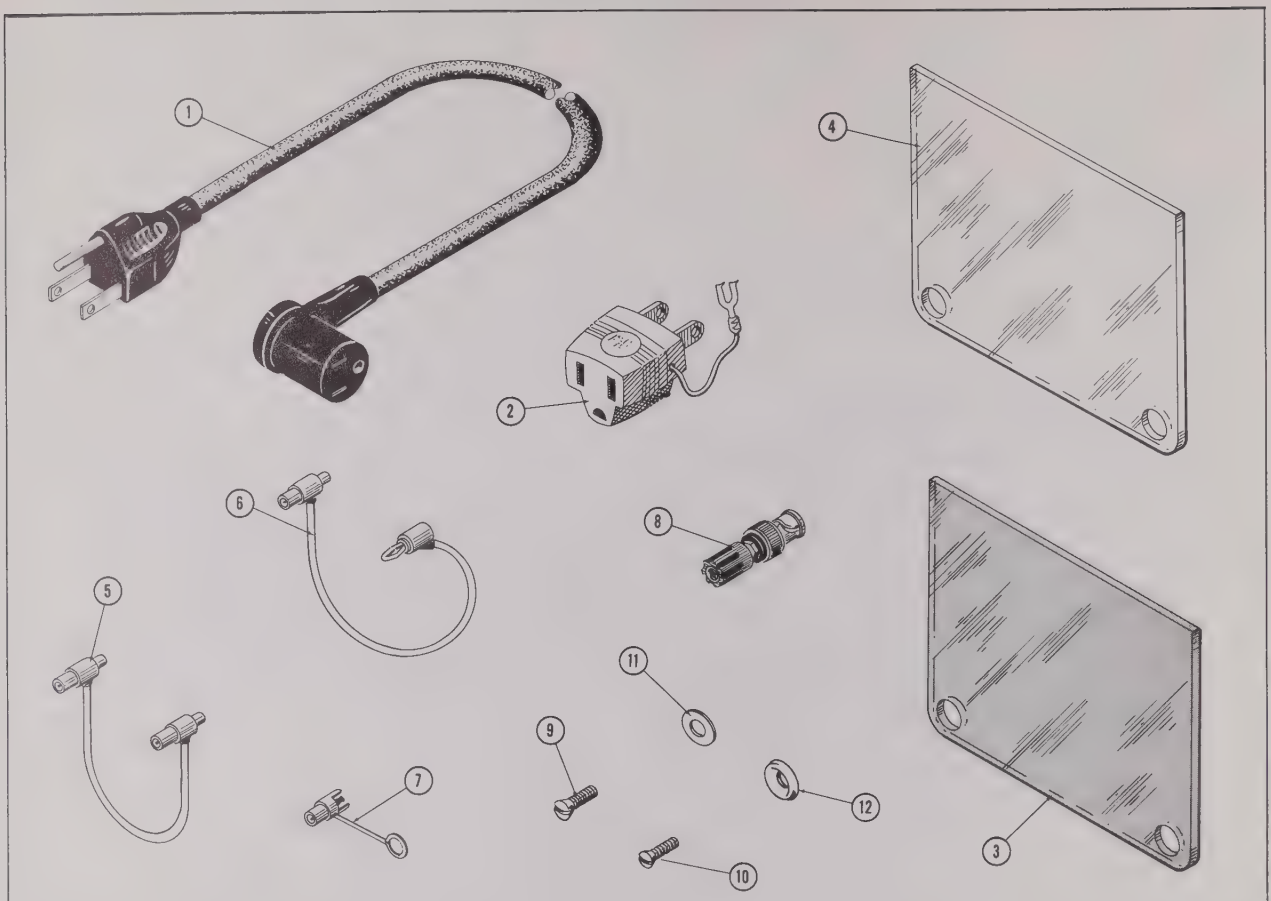
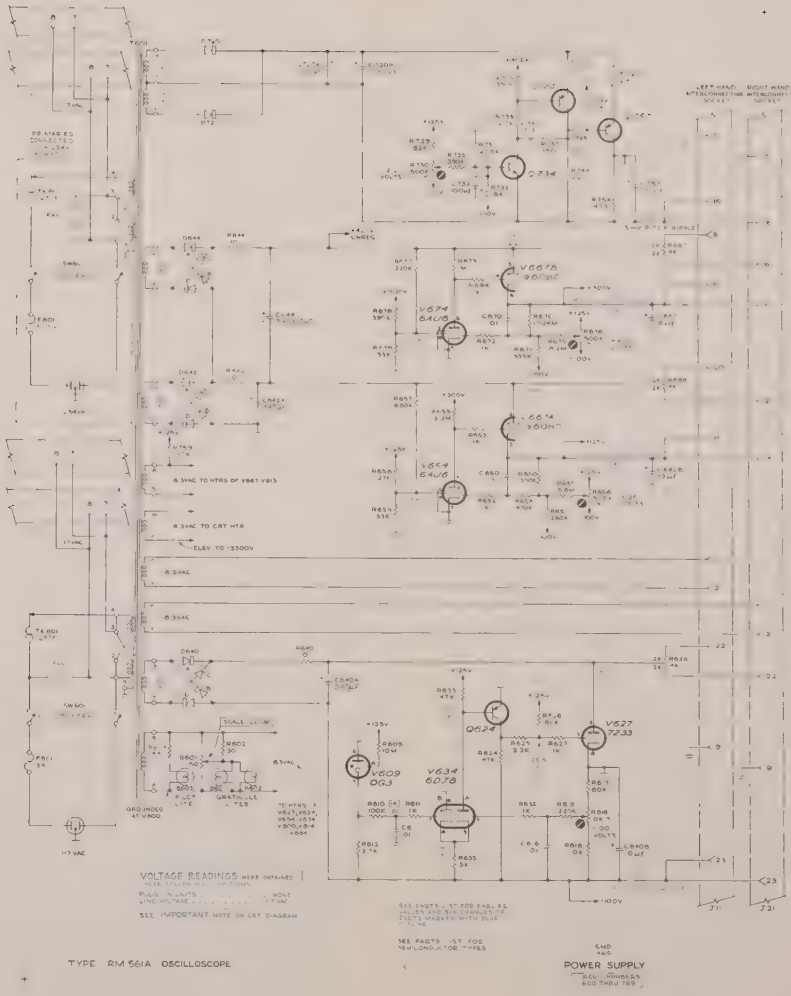
CRT SHIELD

REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
5	136-0035-00			2	SOCKET, graticule light, with ground lug
					Mounting Hardware: (not included)
	211-0534-00			1	SCREW, 6-32 x 5/16 in. PHS, with lockwasher
	210-0803-00			3	WASHER, steel, 6L x 3/8 in.
	210-0006-00			1	LOCKWASHER, steel internal #6
	210-0407-00			1	NUT, hex, brass, 6-32 x 1/4 in.
6	406-0847-00			1	BRACKET, CRT Shield, left
	406-0846-00			1	BRACKET, CRT Shield, right
					Mounting Hardware: (not included)
	212-0004-00			2	SCREW, 8-32 x 5/16 in. BHS
	212-0070-00			1	SCREW, 8-32 x 5/16 in. FHS, phillips
	210-0458-00			3	NUT, keps, steel, 8-32 x 11/32 in.
	211-0534-00			2	SCREW, 6-32 x 5/16 in. PHS, with lockwasher
	210-0006-00			2	LOCKWASHER, steel, internal #6
	210-0407-00			2	NUT, hex, brass, 6-32 x 1/4 in.
7	136-0136-00	5001	5729	1	SOCKET, CRT assembly
	136-0177-00	5730		1	SOCKET, CRT assembly
					Consisting of:
	131-0178-00			9	CONNECTOR, cable end
	136-0117-00			1	SOCKET, CRT 14 pin
	210-0849-00			2	WASHER, fiber #4, shoulder
	210-0850-00			2	WASHER, steel, #2, flat
	213-0116-00			2	SCREW, thread, cutting, #2 x 9/16 in., steel
	337-0456-00			1	SHIELD, CRT socket
	387-0393-00			1	PLATE, back, CRT socket
8	406-0867-00			1	BRACKET, CRT mounting
					Mounting Hardware: (not included)
	211-0504-00			1	SCREW, 6-32 x 1/4 in. BHS
	211-0507-00			2	SCREW, 6-32 x 5/16 in. BHS
	210-0803-00			2	WASHER, steel, 6L x 3/8 in.
9	337-0530-00			1	SHIELD, CRT
10	352-0044-00			1	HOLDER, form coil, CRT polypropylene, black
	211-0011-00	5001	7909	1	SCREW, 4-40 x 5/16 in. BHS
	211-0110-00	7910		1	SCREW, 4-40 x 5/16 inch PHB phillips
	211-0004-00			1	LOCKWASHER, steel, internal #4
	210-0406-00			1	NUT, hex, brass, 4-40 x 3/16 in.

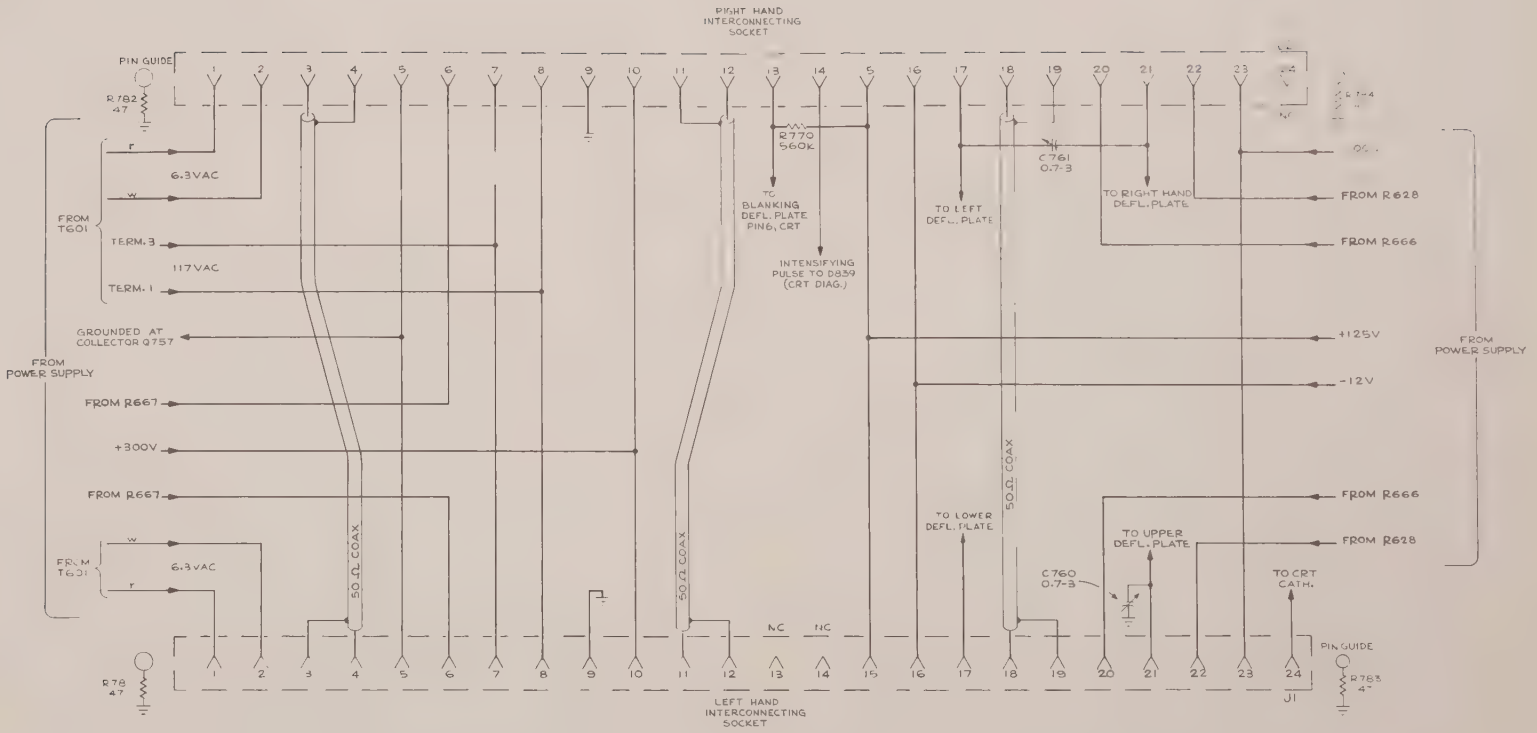
STANDARD ACCESSORIES



REF. NO.	PART NO.	SERIAL/MODEL NO. EFF.	SERIAL/MODEL NO. DISC.	QTY.	DESCRIPTION
1	161-0013-00	5001	7499	1	CORD, power
	161-0022-00	7500	8829	1	CORD, power
	161-0024-00	8830		1	CORD, power
2	103-0013-00			1	ADAPTER, 3 to 2-wire
3	378-0534-00	5001	6885	1	FILTER, green
	378-0544-00	6886	8607	1	FILTER, smoke gray (installed)
	378-0560-00	8608		1	FILTER, smoke gray (installed)
4	387-0935-00	X6886		1	PLATE, protector
5	012-0031-00	X6200	7978	1	CORD, patch
	012-0087-00	7979		1	CORD, patch
6	012-0091-00	X7979		1	CORD, patch
7	012-0092-00	X7979		1	JACK, BNC-post
8	103-0033-00	X5280	X7978X	2	ADAPTER, BNC to binding post
9	212-0512-00			4	SCREW, 10-32 x 1/2 OHS
10	212-0561-00			4	SCREW, 12-24 x 1/2 OHS
11	210-0833-00			4	WASHER, teflon
12	210-0917-00			4	WASHER, steel, finishing #10
- -	070-0352-01			2	MANUAL, instruction (not shown)



TYPE RM 561A OSCILLOSCOPE



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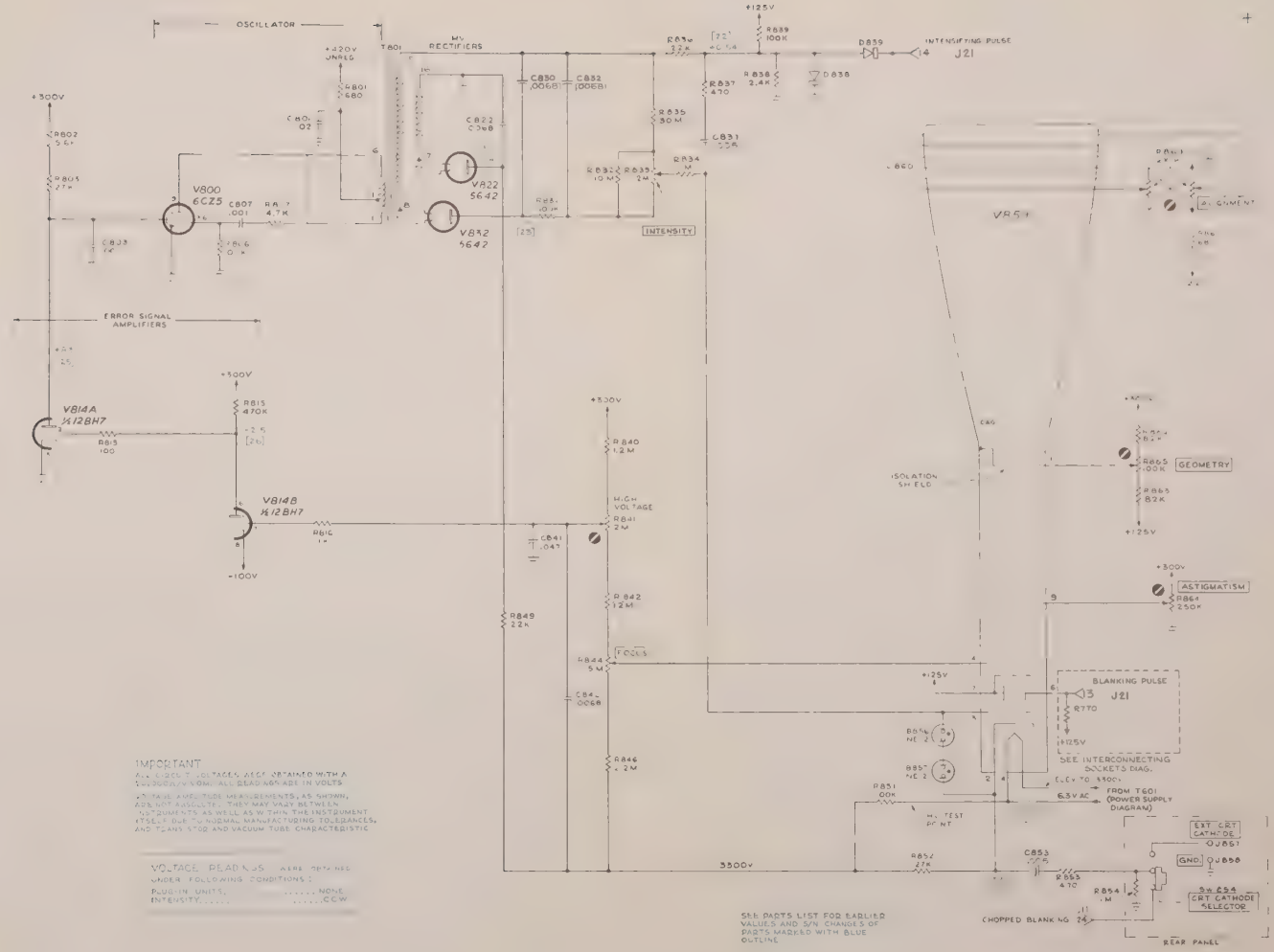
TYPE RM561A OSCILLOSCOPE

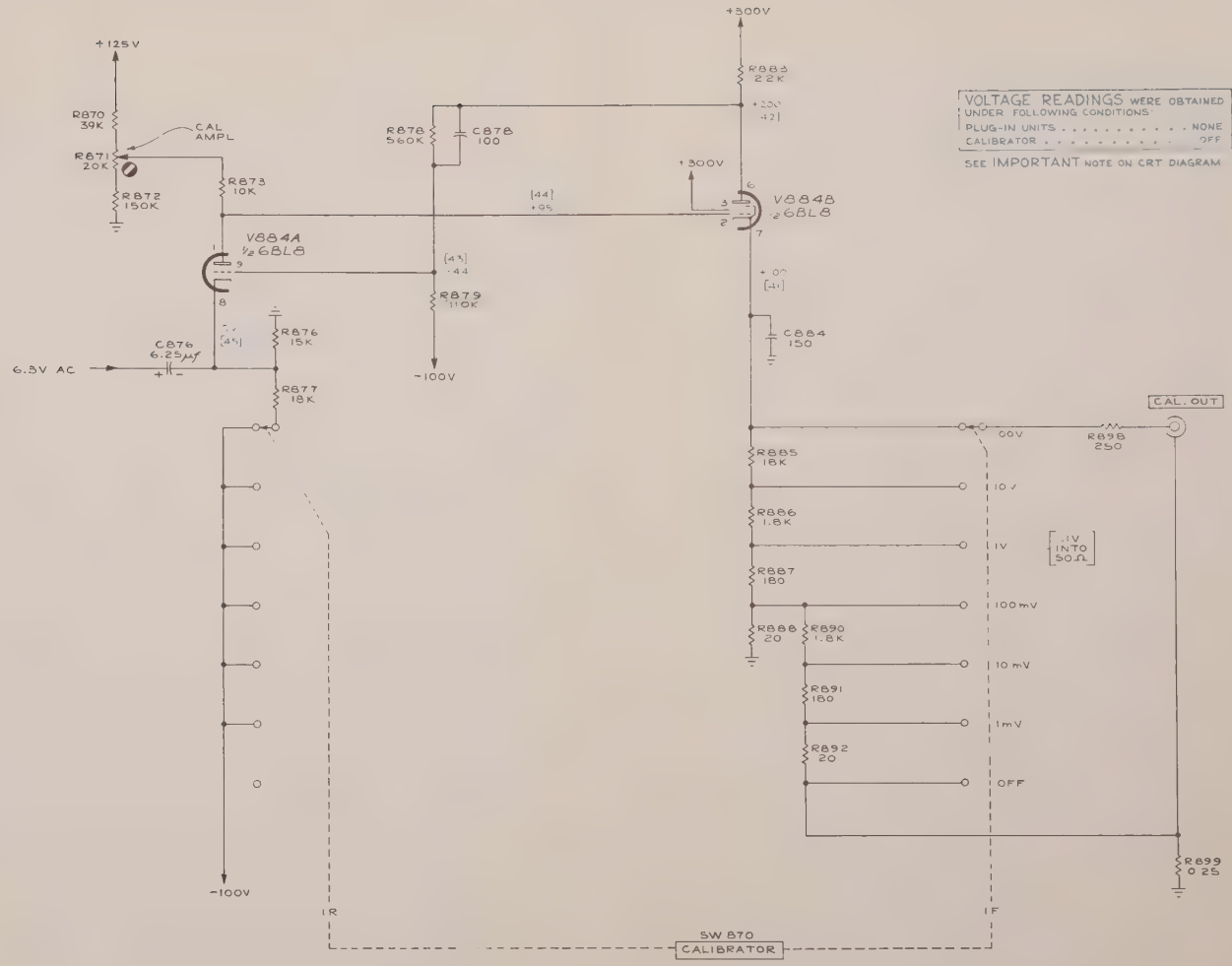
INTERCONNECTING SOCKETS



TYPE RM561A OSCILLOSCOPE

CRT CIRCUIT

CIRCUIT NUMBERS 800 THRU 869



TYPE RM561A OSCILLOSCOPE

B

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH BLUE OUTLINE

PLM 1063

CALIBRATOR

RACKMOUNTING

General Information

This instrument is designed to fit most 19-inch wide racks with EIA standard dimensions. The instrument front panel requires at least a 7-inch high mounting space.

The last foldout page is a dimensional drawing of the instrument. Any plug-in units, probes, or other accessories that may be used with this instrument are not shown.

Determining the Mounting Method

Use Method 1 if the instrument is to be mounted directly to the front rail of the rack as shown in Fig 2. Use Method 2 if the instrument is to be mounted in the rack with slide-out tracks, and the rack has both front and rear rails (see Fig. 3). Use Method 3 for racks that have only a front rail or do not have the proper dimensions between front and rear rails (see Fig. 4).

Enough space should be provided between the rear of the instrument and any obstruction at the rear of the rack to allow for proper air circulation and power cord clearance. At least 60 cu. ft. of air per minute at a temperature less than 50°C should pass through the instrument.

The mounting method will determine the effective panel thickness of the instrument. If the instrument is bolted directly to the rack (Method 1) effective panel thickness will be $\frac{7}{32}$". When slideout tracks are used, the surface of the instrument panel may be as little as $\frac{7}{32}$" from the rack-mounting surface, or as much as $\frac{5}{16}$", depending on the type of screws used and whether the front flanges of the slideout tracks are mounted behind the front rail (Fig. 9c) or in front of it (Fig. 8c). For minimum effective panel thickness, countersink flat-head screws into the front rail of the rack. However, this should not be attempted with racks having thin sheet metal mounting rails.

NOTE

If slideout tracks are used (mounting Methods 2 and 3), the opening between the front rails of the rack must be at least 17⅜" for a rack in which the front flange of the slideout-track stationary section is mounted behind the front rail as shown in Fig. 9c; at least 17¾" if the flange is mounted in front of the front rail as shown in Fig. 8c; or at least 17$^{13}/_{14}$" if the instrument is mounted in a cradle assembly as shown in Fig. 4.

Method 1—Direct Rackmounting

This type of mounting is intended for instruments which are not equipped with slideout tracks. The front panel of the instrument has two notches on each side so the instrument can be mounted directly to the front rail of the rack. Front-panel dimensions and notch locations are shown on the Dimensional Drawing. When mounted in this manner, the rear of the instrument does not need support unless subjected to shock or vibration. Braces can be added at the rear of the instrument if more support is needed.

To mount the instrument directly to the front rails of the rack (see Fig. 2) proceed as follows:

1. Select four oval-head screws (10-32 or 12-24) that match the tapped holes in the rack front rail from the hardware kit. If the holes in the front rail are not tapped, nuts, washers, and longer screws must be used.
2. First, place a cup washer and then a plastic washer on each screw. The plastic washers will protect the instrument front panel.
3. Hold the instrument in the desired position in the rack and fasten securely to the front rail with the oval-head screws

Method 2—Rackmounting With Slideout Tracks

An instrument which has slideout tracks (optional item) can be mounted in a rack which has a rear support rail to which the reversible rear support bracket can be attached. Mounted in this manner, the instrument is locked into the rack with the two RELEASE knobs on the front panel. When the instrument is released from the rack, it can be pulled out to the fully extended position (see Fig. 3) and then tilted up or down and locked in one of six positions: 45°, 90°, and 105° above or below horizontal. These positions permit most routine maintenance and calibration functions to be performed without removing the instrument from the rack.

The slideout tracks consist of two assemblies: one for the right and one for the left side. Each assembly consists of three sections as illustrated in Fig. 1. The stationary section attaches to the front and rear rails of the rack and the chassis section attaches to the instrument. The intermediate section fits between the stationary and chassis sections and allows the instrument to be extended out of the rack.

The small-hardware components included with the slideout tracks are shown in Figs. 5 and 6. The hardware shown in Fig. 5 is used to mount the stationary sections to the rack. The hardware shown in Fig. 6 is used to mount the chassis sections to the instrument. Since the hardware included is intended to make the slideout tracks compatible to a variety of racks, there will be more parts than needed for this installation. Use only the necessary hardware as described in the following procedures.

Chassis Section Installation—Use the following procedure to attach the chassis sections if they are not already installed. See Fig. 6 for installation details.

1. Remove the plug-in units (if any) from their compartments.
2. Remove the bottom dust cover from the instrument.
3. Remove the nut, lockwasher, and flat washer from the eccentric pivot screw on the chassis section. Hold the chassis section parts, including the pivot screw, so the assembly does not fall apart.
4. Mount the assembly so the pivot screw goes into the hole provided and the detent bar assembly is aligned with the prepunched holes on the side of the instrument.
5. Replace the hardware removed in step 3. Do not tighten the nut.
6. Fasten the detent bar assembly to the instrument side using six 8-32 BHS screws. Align the detent bar so it is parallel with the bottom of the instrument before tightening the screws.
7. Turn the pivot screw until the outer slide is parallel to the bottom of the instrument. Hold the screw in this position and tighten the nut.
8. Make sure the detent release knob is screwed tightly into the detent bar.

Stationary Section Installation—The stationary and intermediate sections of the slideout tracks are shipped as matched sets and should not be separated. The assembly for the right side of the rack is shown in Fig. 1. Use the following procedure to mount both sets. Installation details are shown in Figs. 7, 8, and 9.

1. If the instrument is to be mounted directly above or below another instrument in the rack, select the proper front-rail mounting holes using the measurements shown in Fig. 7.
2. If the mounting holes are tapped for 10-32 screws, the left stationary section can be mounted in front of the rail as shown in Fig. 8c provided the distance between the front rails is a minimum of 17¾". Mount the rear support as shown in Figs. 8a or 8b. Using Fig. 8 as a guide, mount the right stationary section. (Note: If the mounting holes are tapped but the distance between the front rails is less than specified, the mounting holes should be drilled out and the stationary section mounted as described in the following step.)
3. If the mounting holes are not tapped for 10-32 screws, mount the left stationary section behind the front rail as shown in Fig. 9c. Mount the rear support as shown in Figs. 9a or 9b. Using Fig. 9 as a guide, mount the right stationary section.

Instrument Installation—Before installing the instrument, check the alignment of the chassis sections as shown in Fig. 12. Be sure the outer slides are parallel with each other. To install the instrument in the rack, follow the step-by-step procedure given in Fig. 10.

Adjustments—To adjust the slideout tracks for best operation, use the following procedure:

1. Position the instrument in the rack as shown in Fig. 11. Follow the adjustment procedure given in Fig. 11 to horizontally center the instrument in the rack. To center the instrument vertically, use the same procedure but move the instrument up or down for proper spacing.
2. If the instrument does not slide smoothly (even after the centering adjustment), pull the instrument out of the rack and loosen the screws that hold the rear brackets to the rear rail. Push the instrument completely into the rack and tighten the screws.

Method 3—Rackmounting With a Cradle Assembly

A cradle assembly (optional) can be used to mount the instrument in a rack which has only a front rail or does not not have the proper dimensions between the front and rear rails. The cradle assembly provides a rear support for the slideout tracks without affecting their operation. Additional bracing should be added to the rear of the cradle assembly if severe vibration or shock is anticipated.

Mounting instructions for this type of installation are included with the cradle assembly. The cradle assembly can be ordered from your Tektronix Field Office or representative.

Maintenance

The slideout tracks require no lubrication. The special finish on the sliding surfaces provides permanent lubrication.

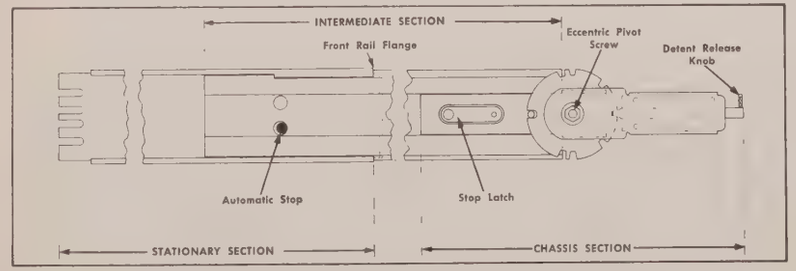


Fig. 1. Slideout track assembly for right side.

Fig. 2. The instrument mounted directly to the front rail (Method 1).

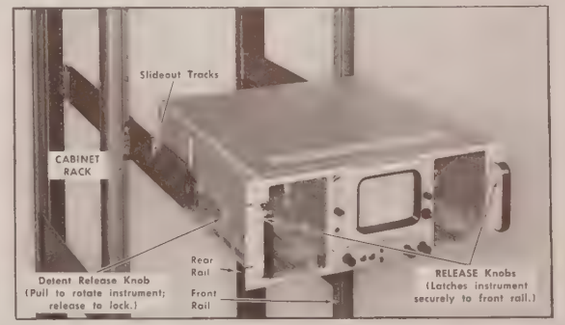

Slideout Tracks
CABINET RACK
Detent Release Knob (Pull to rotate instrument; release to lock.)
Rear Rail
Front Rail
RELEASE Knobs (Latches instrument securely to front rail.)

Fig. 3. The instrument mounted with slideout tracks, supported at front and rear (Method 2)

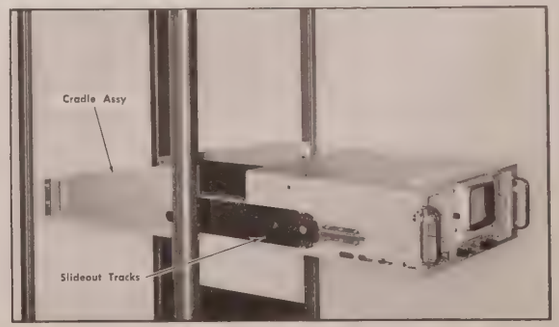


Fig. 4. The instrument mounted with a cradle assembly to support the rear (Method 3).

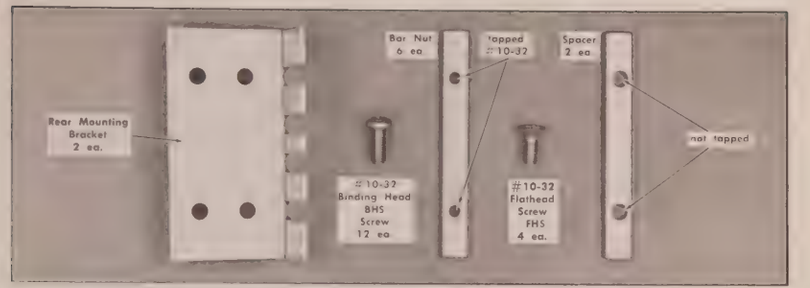


Fig. 5. Small hardware components for mounting the stationary sections to the rack rails.

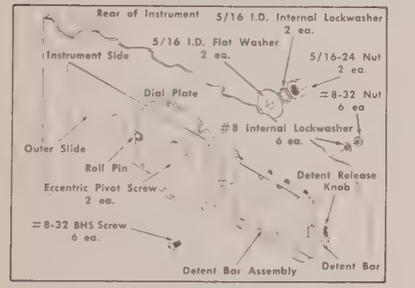


Fig. 6. Details for mounting the left chassis section to the instrument

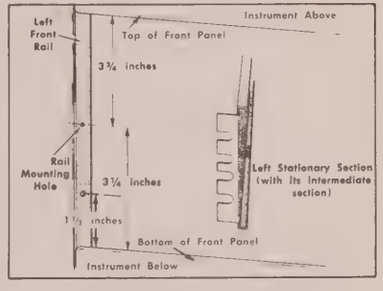


Fig. 7. Vertical mounting position of left stationary section. The same dimensions apply to the right stationary section.

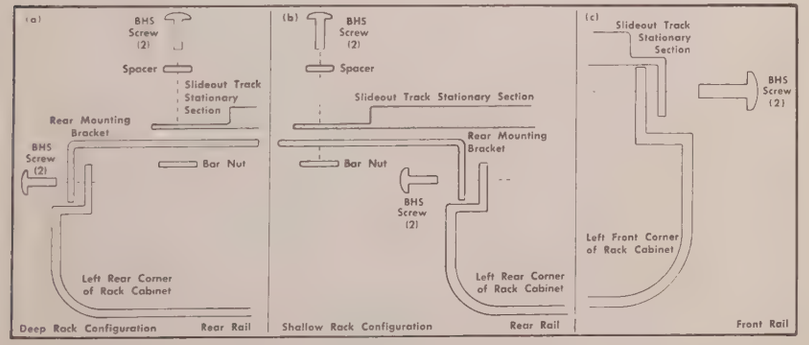


Fig. 8. Mounting the left stationary section to front rail tapped for 10-32 screws.

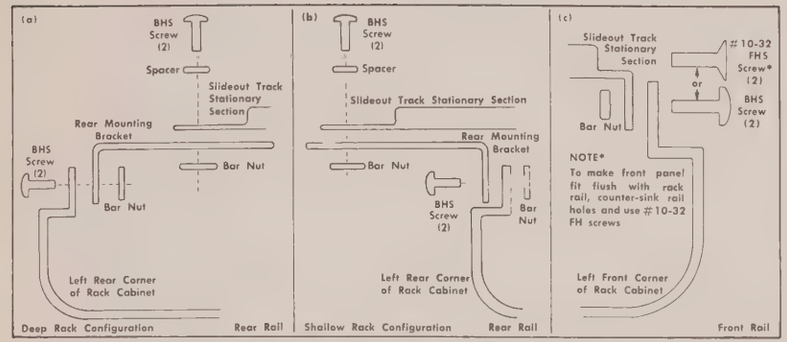


Fig. 9. Mounting the left stationary section to untapped front rail.

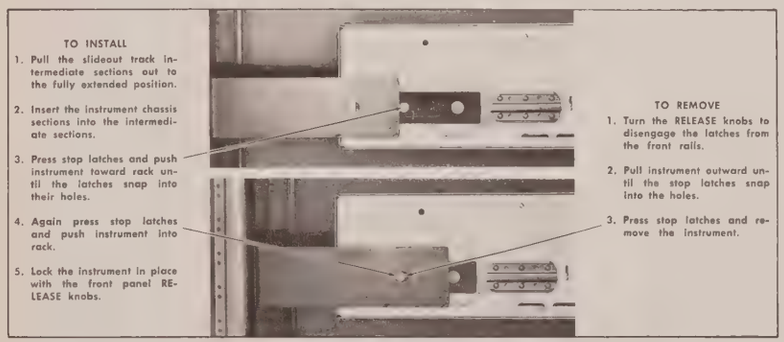

TO INSTALL
1. Pull the slideout track intermediate sections out to the fully extended position.
2. Insert the instrument chassis sections into the intermediate sections.
3. Press stop latches and push instrument toward rack until the latches snap into their holes.
4. Again press stop latches and push instrument into rack.
5. Lock the instrument in place with the front panel RELEASE knobs.
TO REMOVE
1. Turn the RELEASE knobs to disengage the latches from the front rails.
2. Pull instrument outward until the stop latches snap into the holes.
3. Press stop latches and remove the instrument.

Fig. 10. Installing and removing the instrument.

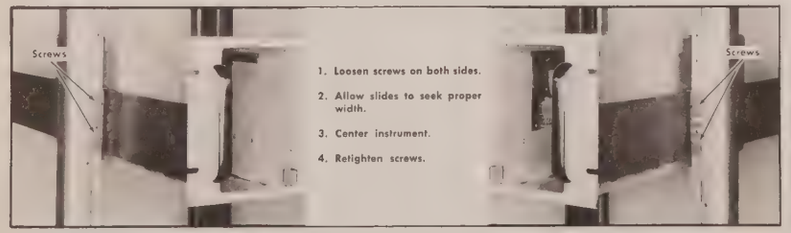


Fig. 11. Adjustment of the slideout tracks.

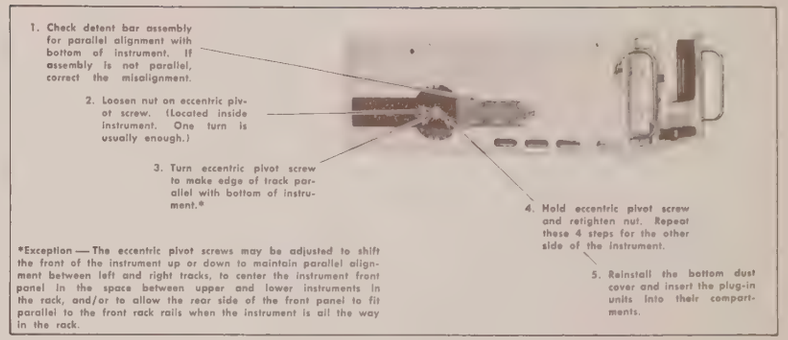

1. Check detent bar assembly for parallel alignment with bottom of instrument. If assembly is not parallel, correct the misalignment.
2. Loosen nut on eccentric pivot screw. (Located inside instrument. One turn is usually enough.)
3. Turn eccentric pivot screw to make edge of track parallel with bottom of instrument.*
4. Hold eccentric pivot screw and retighten nut. Repeat these 4 steps for the other side of the instrument.
5. Reinstall the bottom dust cover and insert the plug-in units into their compartments.
*Exception — The eccentric pivot screws may be adjusted to shift the front of the instrument up or down to maintain parallel alignment between left and right tracks, to center the instrument front panel in the space between upper and lower instruments in the rack, and/or to allow the rear side of the front panel to fit parallel to the front rack rails when the instrument is all the way in the rack.

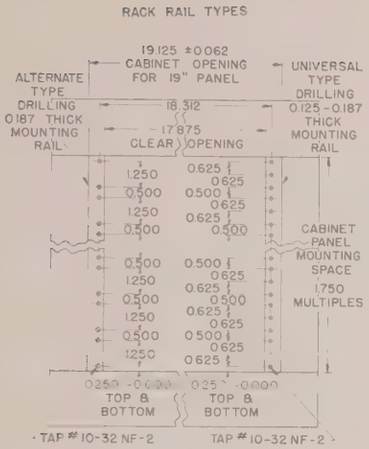
Fig. 12. Adjustment of the chassis section.

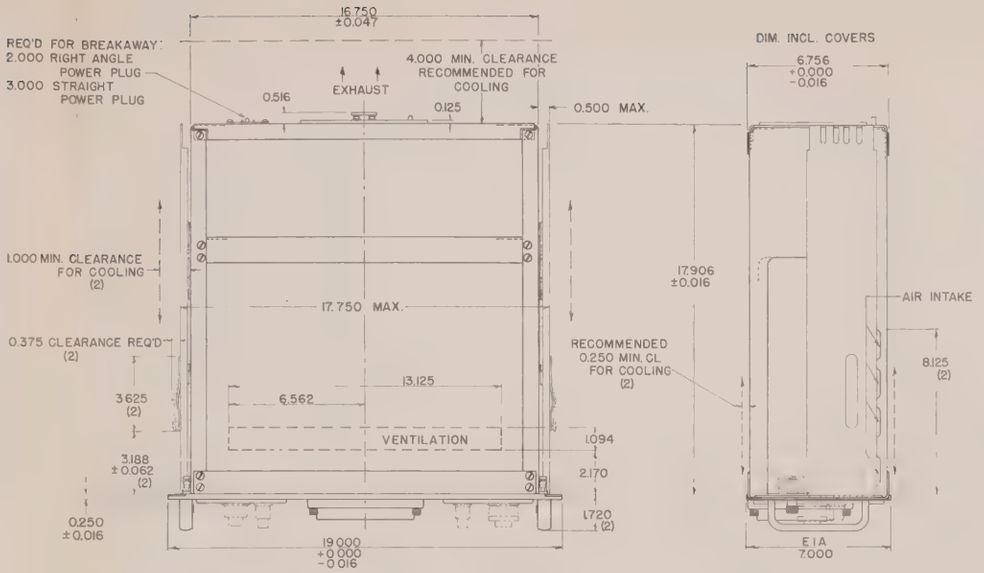
PARTS LIST

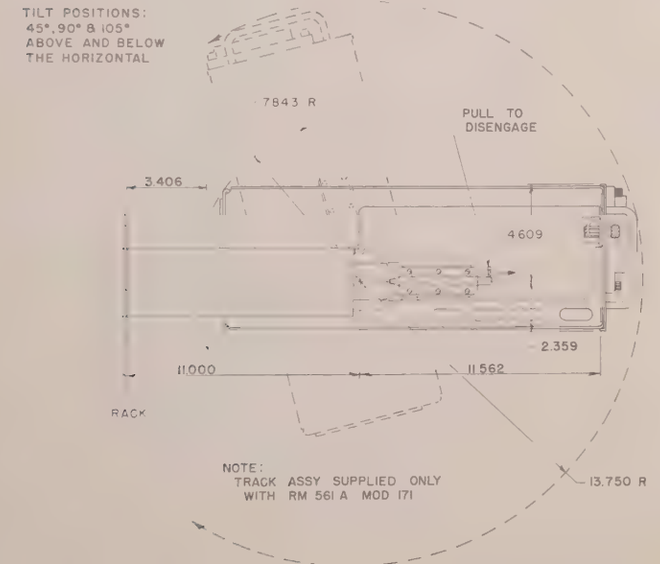
SLIDEOUT TRACK ASSEMBLY

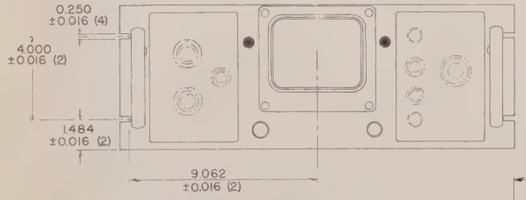
REF. NO.	PART NO.	SERIAL NO. EFF.	SERIAL NO. DISC.	QTY	DESCRIPTION
See Fig 1	351-050			1	TRACK, SLIDEOUT, ASSEMBLY
	. .				Consisting Of:
	351 027			1	TRACK, SLIDEOUT, chassis section
	. .				Mounting Hardware Included:
	NO NUMBER			12	SCREW
	NO NUMBER			12	LOCKWASHER
	NO NUMBER			12	NUT
	351 011			1	TRACK, SLIDEOUT, stationary and intermediate sections, right
	. .				Mounting Hardware Included:
	NO NUMBER			1	BRACKET
	NO NUMBER			1	SPACER
	NO NUMBER			3	SPACER, with threaded holes
	NO NUMBER			2	SCREW, FHS, phillips
	NO NUMBER			6	SCREW, phillips
	351-010			1	TRACK SLIDEOUT, stationary and intermediate sections, left
	. . . .				Mounting Hardware Included:
	NO NUMBER			1	BRACKET
	NO NUMBER			1	SPACER
	NO NUMBER			3	SPACER, with threaded holes
	NO NUMBER			2	SCREW, FHS, phillips
	NO NUMBER			6	SCREW, phillips

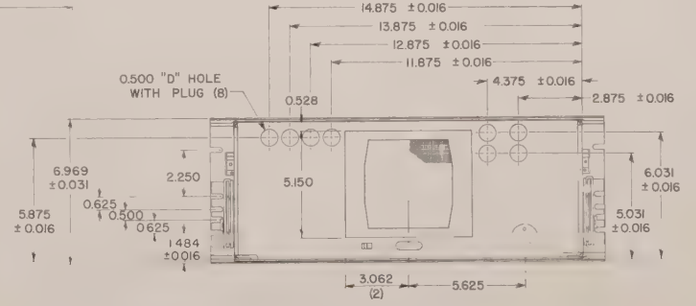
RACK RAIL TYPES



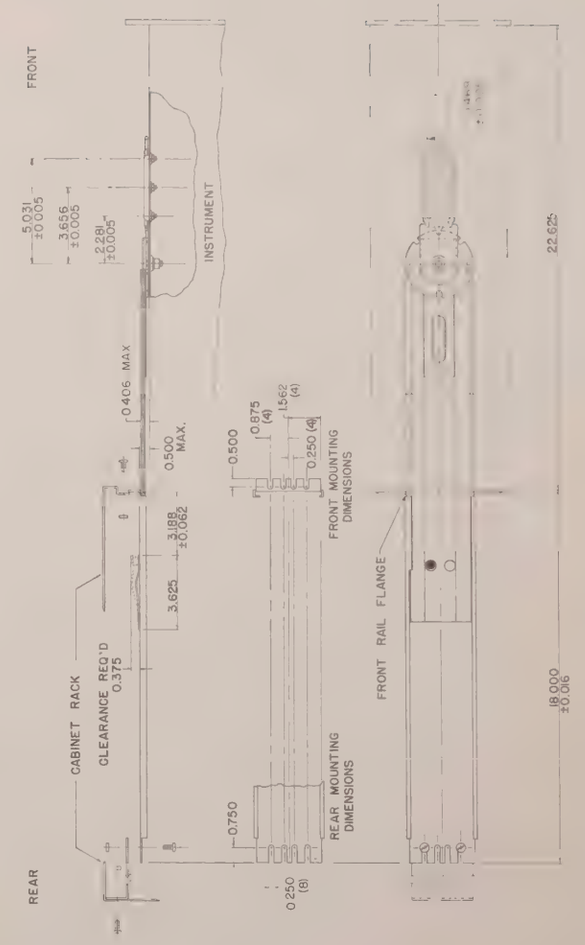








REAR VIEW



( ) NUMBER OF TIMES DIMENSION OCCURS

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages. If it does not, your manual is correct as printed.

TYPE RM561A TENT SN 10060

PARTS LIST CORRECTION

CHANGE TO:

R617	308-0186-01	80 kΩ	1 W	WW	1%

TYPE RM561A TENT SN 10220

PARTS LIST CORRECTION

CHANGE TO:

D640A, B, C, D	152-0066-00	Silicon
D642A, B, C, D	152-0066-00	Silicon
D644A, B, C, D	152-0066-00	Silicon

M9973/766

TYPE RM561A

PARTS LIST CORRECTION

ACCESSORIES, Page 8-14

Instruction MANUAL Part No. changed to 070-0352-01.

ADDENDUM TO MANUAL

ME-1904

OSCILLOSCOPE

TYPE RM561A

TEKTRONIX

MAY 23, 1972

THIS ADDENDUM INCORPORATES EC: 0197-915. INSERT THIS ADDENDUM INTO THE MANUAL FOR FURTURE REFERENCE

SERIAL NUMBERS 013433 (HSK), 013431 (MAD), AND 013432(GDS) WERE MODIFIED TO PROVIDE REAR PANEL INPUT CAPABILITY FOR OSCILLOSCOPES INSTALLED IN THE APOLLO TV MONITOR SYSTEM, (11H).

THE VERTICAL INPUT CHANNEL AND EXTERNAL TRIGGER INPUTS WERE PARALLELED TO THE REAR OF THE OSCILLOSCOPE TO PERMIT HARDWIRED PERMANENT CABLING.

COMPATIBILITY

ALL 2- AND 3- SERIES PLUG-INS INTENDED FOR USE IN AN RM561A, OR RM564, WHETHER THE PLUG-IN IS MODIFIED FOR REAR CONNECTORS OR NOT, WILL OPERATE NORMALLY IN A MODIFIED INDICATOR. HOWEVER, THERE COULD BE NOISE PROBLEMS WITH ONE OF THE MORE SENSITIVE PLUG-INS HAVING AN OPEN INPUT CONNECTOR AT THE REAR OF THE PLUG-IN FACING INTO AN INDICATOR POWER SUPPLY.

CHANGES IN ELECTRICAL CHARACTERISTICS

THE SYSTEM IS BASICALLY INCOMPATIBLE WITH CONVENTIONAL X10 OR X100 HIGH-IMPEDANCE PROBES. THIS IS BECAUSE THE INPUT CAPACITY OF THE PLUG-IN IS RAISED TO APPROXIMATELY 100pF, PLUS THE CAPACITANCE OF THE CIRCUITRY ATTACHED TO THE REAR CONNECTOR.

OPTIMUM TRANSIENT RESPONSE FOR 10 MHz INSTRUMENTS MAY BE PRESERVED BY TERMINATING AT THE FRONT PANEL CONNECTOR FOR SIGNALS APPLIED TO THE REAR PANEL CONNECTOR. THERE WILL BE SOME DEGRADATION OF THE TRANSIENT RESPONSE IN 10 MHz INSTRUMENTS FOR SIGNALS APPLIED TO THE FRONT PANEL INPUT OR TERMINATED AT THE REAR PANEL. FOR LOWER BANDWIDTH INSTRUMENTS, THE ONLY NOTICEABLE EFFECT WILL BE THAT OF THE INCREASED CABLE CAPACITANCE ON SIGNALS FROM SOURCES GREATER THAN 50 OHM.

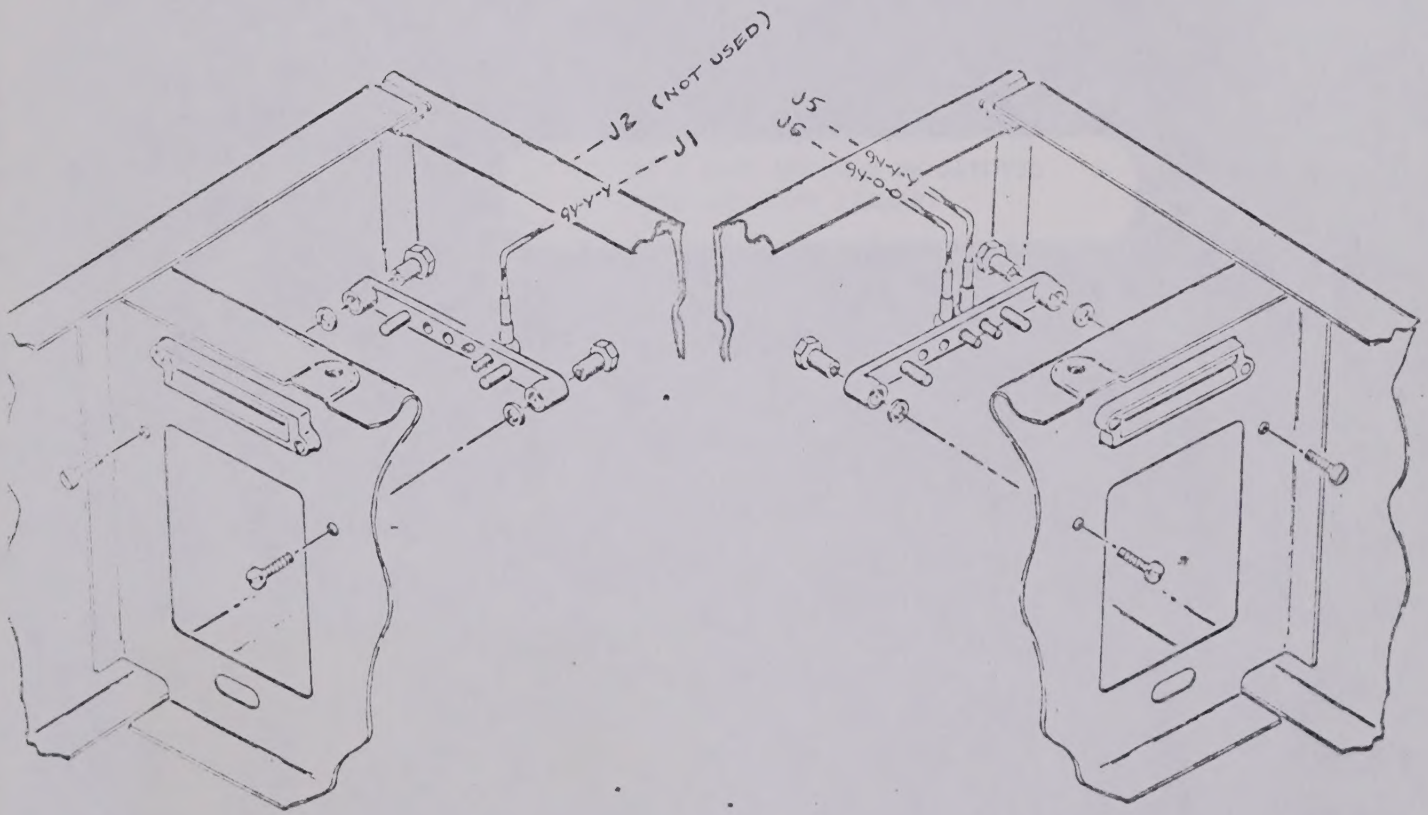
CONNECTOR EXTRACTION

THE CANNON DM SERIES MINIATURE CONNECTORS MAY BE REMOVED FROM THEIR DELRIN HOLDERS BY USING A SPECIAL TOOL AVAILABLE FROM CANNON ELECTRIC COMPANY. ORDER CONNECTOR EXTRACTOR CET-C6B.

TO USE THE EXTRACTOR, PLUNGE THE TUBING DOWN OVER THE CONNECTOR AS FAR AS IT WILL GO, THEN PUSH THE CONNECTOR OUT WITH THE INNER SHAFT OF THE TOOL.

MECHANICAL PARTS LIST

TEKTRONIX PART NUMBER	DESCRIPTION
131-0410-00	CONNECTOR, COAX, CANNON DM53741-5001
131-0411-00	CONNECTOR, COAX, DAGE #4818-2 BNC
352-0095-00	HOLDER, COAX CONNECTOR, DELRIN
361-0109-00	NUT, SPACER
334-1073-00	PLATE, IDENTIFICATION, J1-J2
334-1074-00	PLATE, IDENTIFICATION, J5-J6
211-0511-00	SCREW, 6-32 X ½PHS, PHILLIPS
361-0110-00	SPACER, FLAT



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